San Francisco – Oakland Bay Bridge
East Span Seismic Safety Project

ARCHAEOLOGICAL ANALYSIS OF CA-SFR-4/H, YERBA BUENA ISLAND

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Summary of Findings

In 1997 the California Department of Transportation (Caltrans) Toll Bridge Program, in conjunction with the Federal Highway Administration, began conducting cultural resource studies for their proposed San Francisco-Oakland Bay Bridge East Span Seismic Safety Project. The project would replace the bridge's east span between Yerba Buena Island in San Francisco Bay and Oakland on the Bay's east shore. Prehistoric and historic-period archaeological site CA-SFR-4/H lay within the project Area of Potential Effects (APE) on Yerba Buena Island. The site had been recorded previously (Dexter 1998; Loud 1934) as a buried prehistoric shell midden and an assemblage of historic-period structural remains associated with nineteenth- and early twentieth-century military use of the island. The State Historic Preservation Officer (SHPO) concurred with Federal Highway Administration's determination that the prehistoric component of the site was eligible for the National Register of Historic Places under Criterion D, for its potential to yield important data about Bay region prehistory (Abeyta 1998). The SHPO also concurred that the surface elements of the historic Naval Training Station component of SFR-4/H did not contribute to the site's eligibility due to lack of integrity; however, there was a potential for buried, unevaluated American-period features or deposits associated with early settlers of the island and/or the Army Post and Depot.

Pre-construction assessments of the effects of the East Span Project on SFR-4/H (Dexter and Benté 1998a) determined that about half the site area would be destroyed by project construction. The primary purpose of the data recovery excavations described in this report was to address adverse effects to the prehistoric component of SFR-4/H and, secondarily, to provide for the compressed evaluation and treatment (consistent with Section 106 of the National Historic Preservation Act) of any historic-period features that might be uncovered during data recovery at the site.

All archaeological excavation for this project was conducted within the Area of Direct Impacts (ADI). The project area on Yerba Buena Island includes state and federal lands, the latter under the jurisdiction of the US Coast Guard. An Archaeological Resources Protection Act permit was required for archaeological excavation in the portion of the APE on federal land. Phase III data recovery excavations were conducted in the fall of 2002, an additional auger program for boundary delineation was conducted at the site in January 2003, and a second phase of archaeological data recovery excavation was carried out in the summer of 2004, focusing on US Coast Guard lands. This report presents the results of all phases of data recovery fieldwork.

A total of about 2,000 cubic meters (2,614 cubic yards) of midden and underlying deposit was excavated during data recovery, through mechanical scraping and volume-controlled hand excavation. Nineteen control units were dug (25.05 cubic meters), primarily in the shell midden component of the site. The entire ADI for the project was then scraped to non-cultural subsoil (1.0-1.5 meters below the midden stratum), while archaeological and Native American monitors observed all earth-moving activities. The archaeologists documented four prehistoric features and recovered 31 burials, along with significant artifacts from the midden. It was during this phase that a previously-undocumented mortuary component was found below the shell midden; as soon as the monitors observed bone, backhoe work was halted, and the remains were excavated by hand.

Three major strata were identified at SFR-4/H: Stratum I was historic fill; Stratum II was a loose, deep, black, shell midden; and Stratum III represented a basal cultural layer of dark, yellowish to light brown sand. Within shell midden Stratum II, three periods of occupation were recognized: Middle, Middle-Late Transition, and Late. Stratum III, in the sub-midden sand, was represented primarily by Early Period burials and their associated artifacts. Stratum II was characterized by a diversified assemblage of flaked, ground, and polished stone, modified bone and shell, floral and faunal remains, and cultural features.

Comparing SFR-4/H subsistence patterns with sites from other Bay Area islands and the nearby East Bay margin has revealed remarkable variation in dietary emphasis. This was due in part to the different constraints

placed on local inhabitants by the availability of food resources within the daily foraging area. Diachronic data, where available, indicate increasing divergence in resource emphasis between local settings in the Bay Area. These results are also consistent with resource intensification models, as foodstuffs that took more time to procure and process became, over time, a more significant contributor to the diet. These trends also reveal that very different social choices were made regarding how and in what manner effort was placed on obtaining more costly resources.

Although the shell midden and overlying fill included an admixture of late nineteenth- and early twentieth-century materials in some areas, no historic-era deposits or features were uncovered that could be attributed to specific occupations, individuals, or uses (e.g., Dowling, one of the first American-period settlers of the island; or Army post and depot occupation). The paucity of historic-era materials confirms that this component of SFR-4/H is not a contributing element to the site's eligibility to the National Register of Historic Places or the California Register of Historical Resources.

Collections and records from the data recovery excavations are planned to be curated at the Phoebe Hearst Museum of Anthropology, University of California, Berkeley. The 13 burials recovered from the portion of the site that lies on State lands have been re-interred on Yerba Buena Island, following osteological and archaeological analysis, in accordance with an agreement between Caltrans and Rosemary Cambra, the appointed Ohlone Most Likely Descendant for the site. As of September 2007, the remains of 18 individuals recovered from the portion of the site administered by the US Coast Guard are being held by Caltrans until a determination can be made for legal disposition in accordance with the federal Native American Graves Protection and Repatriation Act.

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Chapter 1. Introduction

This document reports the methods and results of archaeological investigations at SFR-4/H, a buried prehistoric archaeological deposit and historic-era remains located on Yerba Buena Island in San Francisco Bay, California (Figure 1). Various phases of the investigations took place between September 2002 and August 2004.

During the Loma Prieta Earthquake in 1989, the eastern span of the San Francisco-Oakland Bay Bridge (Bay Bridge) proved to be seismically unsound and in need of replacement. In 1997, the California Department of Transportation (Caltrans) initiated environmental studies for the proposed San Francisco-Oakland Bay Bridge East Span Seismic Safety Project (East Span Project). The project would require demolition and reconstruction of the existing east span of the bridge, including the bridge footing where prehistoric deposits had previously been encountered. The Area of Potential Effects (APE) for the proposed project extended across Yerba Buena Island and archaeological site SFR-4/H (Figure 2 and Figure 3). The site was determined eligible for inclusion on the National Register of Historic Places under Criterion D (Abeyta 1998), for its potential to provide scientific information on issues crucial to the understanding of the prehistory of the San Francisco Bay region (cf. Dexter and Benté 1998b). Thus the East Span Project would have an adverse effect on an eligible property.

As for the historic-era component (Maniery et al. 1996), research indicated that this part of the island had been occupied by early settlers from San Francisco who had carried out boat-building and quarrying enterprises here. Subsequently the island was developed as an Army post and depot (1891 and 1918), a Naval Training Station (1898), and military facilities related to World War II. However, research also indicated that the potential for intact historical features or deposits was slight due to the nature of historic-era disposal practices and to subsequent grading of the area. These later uses had almost certainly obliterated any surface or shallow subsurface evidence of the earlier historic-era settlement, although there was still the potential for more deeply buried features such as wells or refuse pits.

Site SFR-4/H lies on lands owned or administered variously by San Francisco County, the State of California, and the US Coast Guard; thus the East Span Project is subject to both the California Environmental Quality Act and the National Historic Preservation Act. To meet the requirements of these regulations, Caltrans contracted with URS Corporation (then Woodward Clyde International-Americas) to conduct a series of archaeological surveys and historical research, augering, and data recovery at SFR-4/H (Dexter and Benté 1998a, 1998b; 1998c, 2003; Morgan and Dexter 2001a). Augering revealed a well-defined, buried prehistoric midden deposit capped by a layer of sandy fill of uneven thickness. Computer modeling of the deposit, based on auger results suggested that some 1,600 cubic meters of midden deposit might remain beneath the asphalt and fill. In addition, late nineteenth-century manual grading had shown that Native American human remains were present in the buried deposit.

The Research Design and Treatment Plan (Plan), developed for the archaeological investigations at SFR-4/H by URS (Morgan and Dexter 2002), was designed to mitigate effects to any components of the site determined to be eligible to the National Register. All fieldwork under the Plan was conducted within the project's Area of Direct Impacts (ADI). Because human remains were known to be present at the site, the Plan called for complete excavation of all midden deposits within the ADI, to ensure that any burials present would be recovered prior to construction. In accordance with the Memorandum of Agreement previously developed for this project (Federal Highway Administration et al. 2000), the Plan was distributed for review and comment to the Ohlone contacts provided by the Native American Heritage Commission.

The Phoebe Hearst Museum of Anthropology, University of California, Berkeley, has agreed to curate archaeological materials from the SFR-4/H excavations when NAGPRA issues have been resolved. The goal is to keep the collection from SFR-4/H together. Assuming that NAGPRA repatriation issues are resolved, all human remains and associated grave goods will be re-interred near the site.

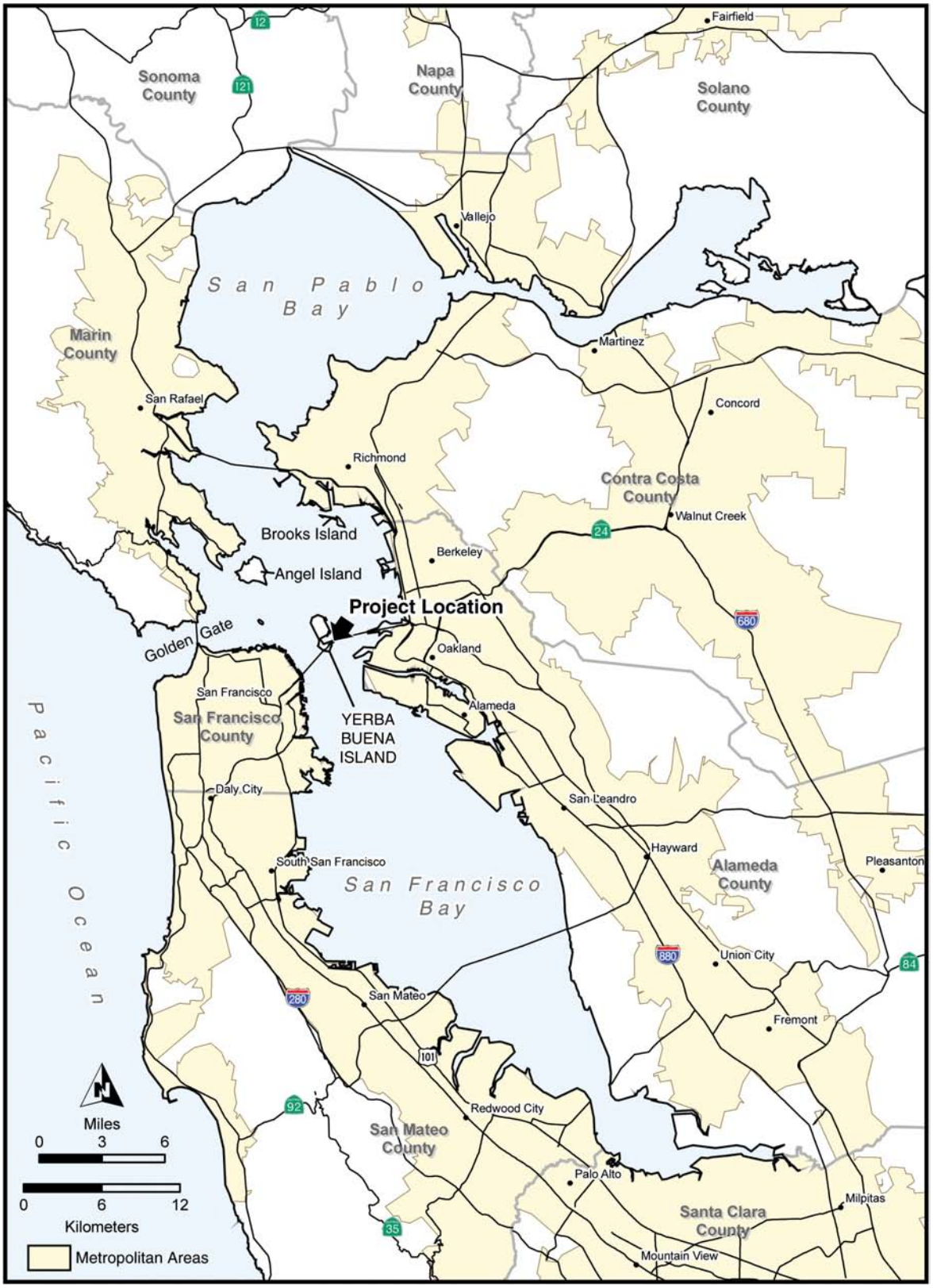


Figure 1. Project Vicinity.

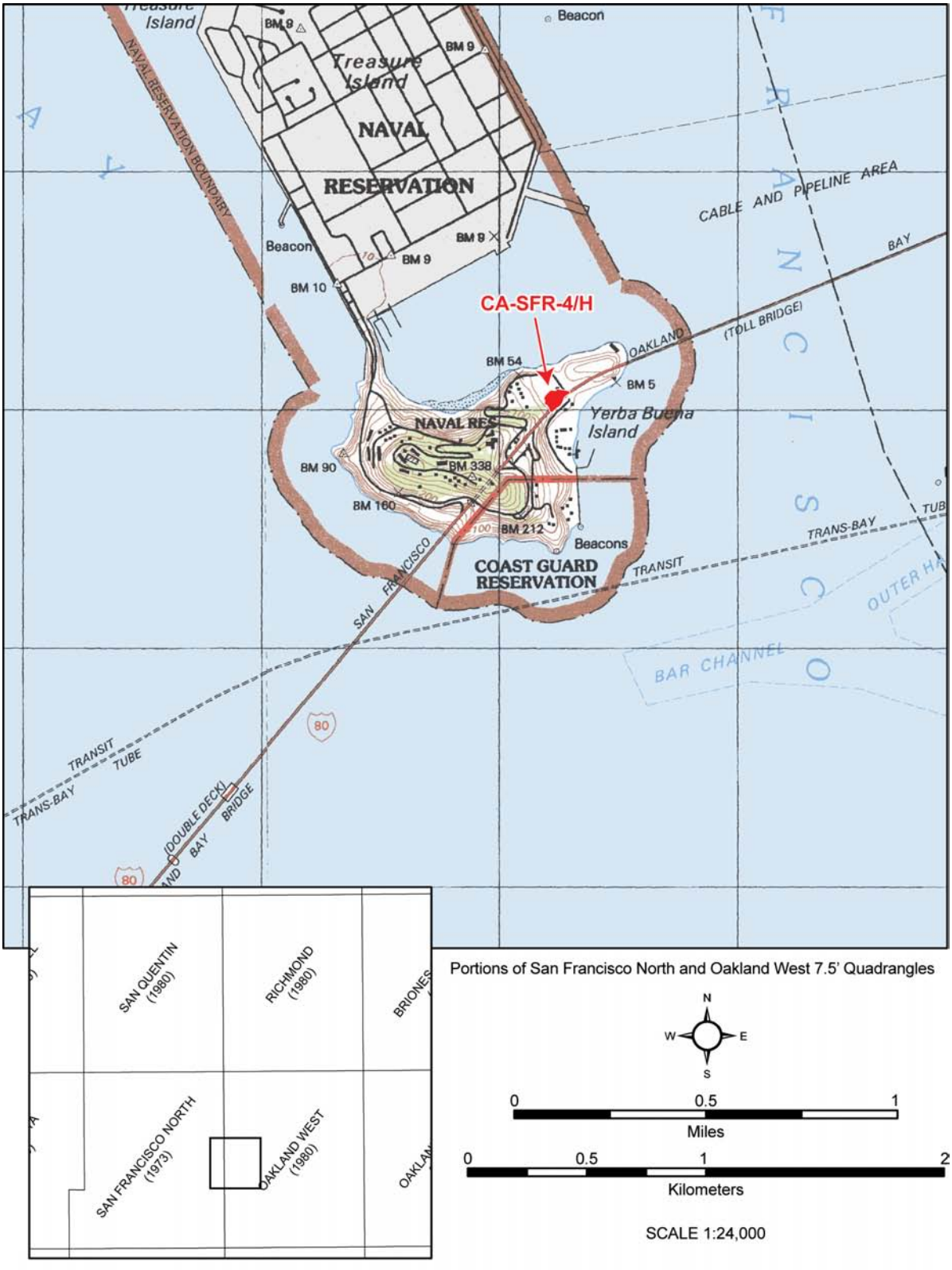
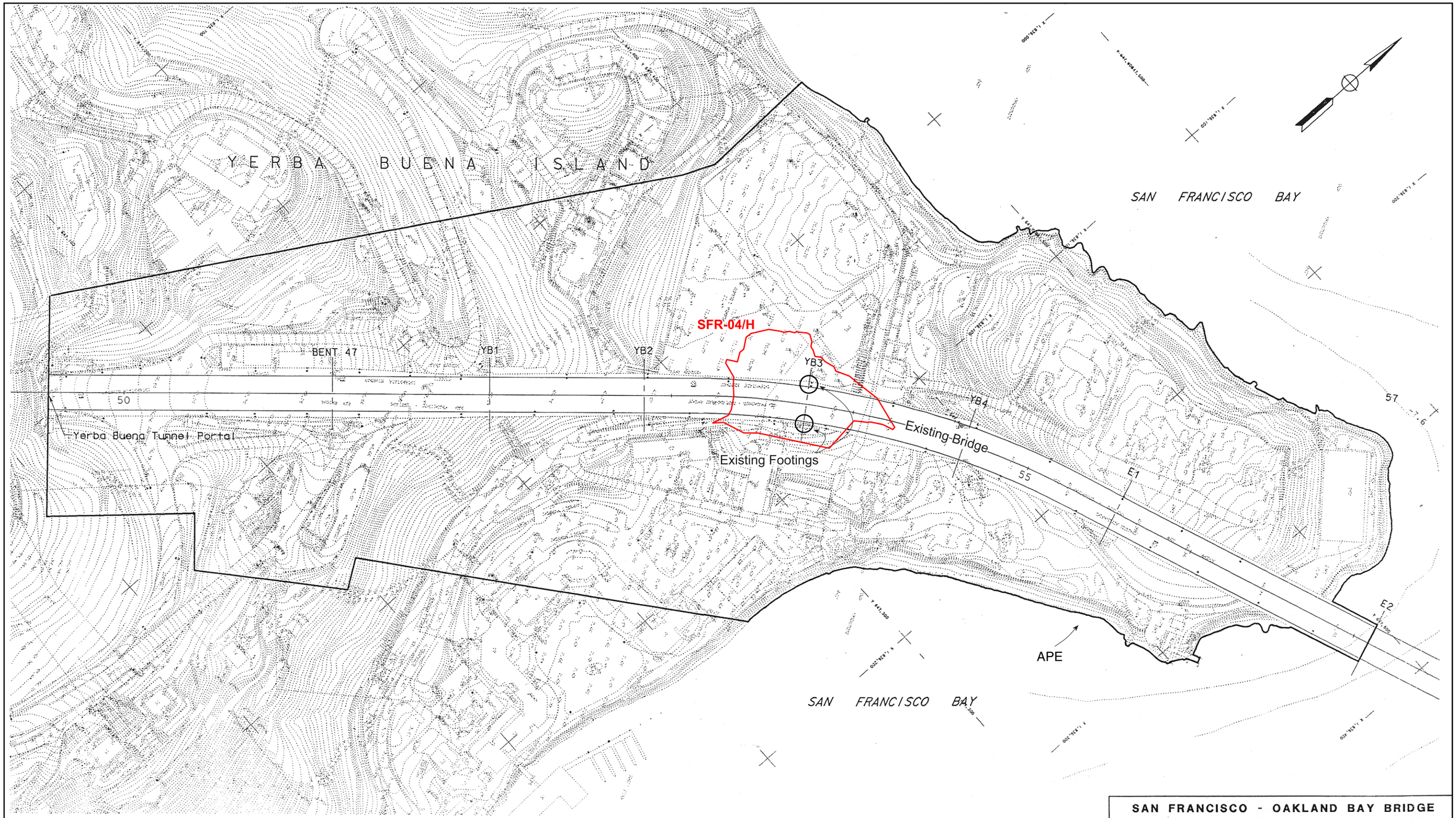


Figure 2. Project Location.



CALTRANS Env. Planning Mara McCarthy 2/9/98

FHWA Area Engineer [signature] 2/18/98

PRELIMINARY
SUBJECT TO REVISION

Caltrans Metric

SAN FRANCISCO - OAKLAND BAY BRIDGE EAST SPAN SEISMIC SAFETY PROJECT

Figure 3. Area of Potential Effects for the San Francisco-Oakland Bay Bridge East Span Seismic Safety Project at Yerba Buena Island.

Prepared By: E. McCarthy	Date: 04 Feb 98	Scale: 1:1000

SITE HISTORY AND DESCRIPTION

Site SFR-4/H was first reported in 1899, when burials were uncovered by workers who were leveling an area near the eastern end of the island to expand a parade ground for the Navy. Workers removed the upper portion of the site but buried the rest under layers of fill, inadvertently protecting it. *The San Francisco Call* (January 21, 1899) reported the discovery of flexed burials, abalone shells (possibly ornaments), a large bowl mortar, pestles, and a bi-pitted cobble. Based on the topographic alteration and the nature of the finds, it appears that the Navy excavations sheared off the upper portions of a shell midden deposit and unknowingly buried the remaining deposit under thousands of cubic feet of fill (cf. Morgan and Dexter 2001a, 2001b, 2002).

In 1934, construction workers rediscovered the site during excavations for a pier for the original Oakland-San Francisco Bay Bridge (Figure 4). UC Berkeley archaeologist L. L. Loud conducted limited archaeological studies that same year but his notes were lost and little is known of his findings. However, the recovered artifacts were curated at the Phoebe Hearst Museum at UC Berkeley. Photographs taken at the time indicate a deeply buried layer of dark soil in the profile of the excavation hole of the pier. No formal data recovery program was undertaken.

In 1997, consultants to the US Navy began to assess archaeological and historic architectural resources on Yerba Buena Island as the Navy prepared to cede Treasure Island Naval Base to the City of San Francisco (Hamusek-McGann et al.1997; JRP Historical Consulting 1997). A site record prepared for SFR-4/H included conjectural boundaries for the buried prehistoric deposit and historic 19th century features (the site designation was revised to SFR-4/H at this time): the deposit was not actually encountered at this time.

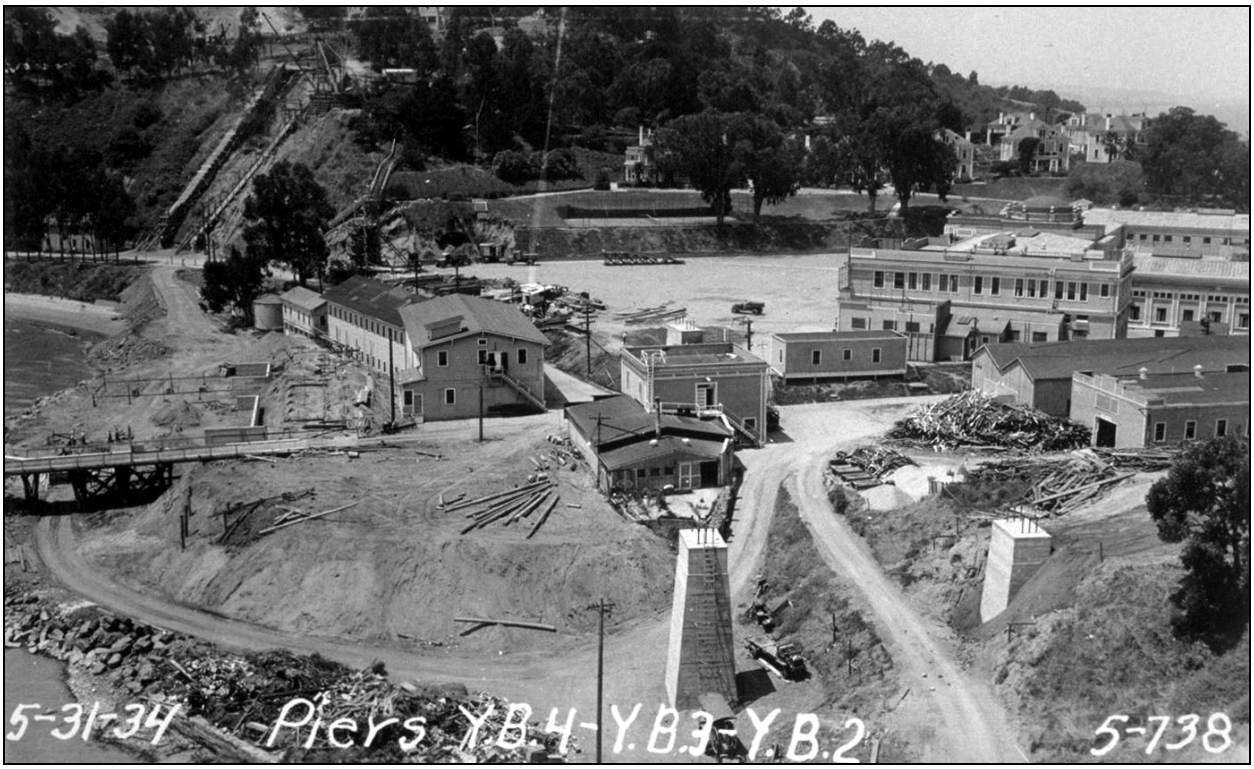


Figure 4. Overview of Excavations in 1934 for Pilings for the Original Oakland-San Francisco Bay Bridge.

In 1998, as the Navy trenched across a paved parking lot to remove outmoded piping, excavators inadvertently exposed buried shell midden deposit within the site area. Consultants under contract to Caltrans began augering to define the prehistoric site boundaries as there was no surficial evidence of the deposit. Computer modeling produced a three dimensional map of the buried SFR-4/H midden deposit. This indicated a shallow but fairly extensive mound deposited on a swale among the dunes, and subsequently covered by fill. In August 1998, the State Historic Preservation Office concurred with Caltrans' findings that the prehistoric component of SFR-4 is a contributing element to the potential eligibility of the site and that the US Naval Training Station is a non-contributing element. Also, they agreed that further investigations were needed to address whether the Army Post and Depot and/or American Period civilian era occupation are contributing or non-contributing components to the potential eligibility of the site as a whole.

Phase III data recovery excavations were conducted by Caltrans District 4 and URS in the fall of 2002 to recover data from the site before construction of the new east span of the Bay Bridge. An additional auger program for boundary delineation was conducted in January 2003, and a second phase of archaeological data recovery excavation was carried out in the summer of 2004, focusing on US Coast Guard lands. Detailed results of the 2002 and 2004 excavations are presented in this report.

PROJECT DESCRIPTION AND DEFINITION OF AREA OF DIRECT IMPACT

The east span of the Bay Bridge will be replaced in an alignment north of the existing bridge by a steel, self-anchored suspension bridge and a concrete skyway to the Oakland touchdown. A concrete transition structure on Yerba Buena Island will connect the new span to the existing double deck configuration at the tunnel. The existing bridge then will be torn down. Two new bridge footings are proposed within the eastern half of SFR-4/H (Figure 5). Existing bridge footings YB-3a and YB-3b, which also stand within the boundaries of the archaeological site, will be removed prior to the new footing installation.

To accommodate construction activity, the project ADI was defined to include all areas of direct disturbance. It is comprised of the footprint of anticipated disturbance associated with the new footing and a 10-meter (31.5-foot) buffer around each side of the footing excavation footprint. Anticipated ground disturbance throughout this area, from bridge demolition, construction, and related activities, will include direct excavation to a depth of at least eight meters (25 feet), and drilling of pilings to much greater depths. The area of anticipated disturbance associated with the removal of existing footing YB-3b lies within the ADI for the new footing. The temporary footings for the south detour were determined during this investigation to lie outside the boundaries of SFR-4/H, and their construction is not expected to affect the site either directly or indirectly.

Within the boundaries of SFR-4/H as it was defined by the 1998 augering program, the East Span Project ADI included approximately 40 percent of the surface area of the site. It was anticipated that any grading or other ground disturbance associated with construction would completely destroy the archaeological deposit within the ADI, with disturbance over much of the area to depths of 30 feet or more below the surface.

PERMITS

An Archaeological Resources Protection Act (ARPA) permit was acquired by Caltrans for investigations on Coast Guard lands (Control No. ARPA 2002-1, August 20, 2002). As part of the permit requirements, a Burial Action Plan was prepared in consultation with Most Likely Descendant to address requirements of the Native American Graves Protection and Repatriation Act with respect to recovery and future repatriation of human remains and associated grave goods and items of cultural patrimony found on federally administered lands. The Burial Action Plan was included in the overall Research Design and Treatment Plan for the site (Morgan and Dexter 2002).

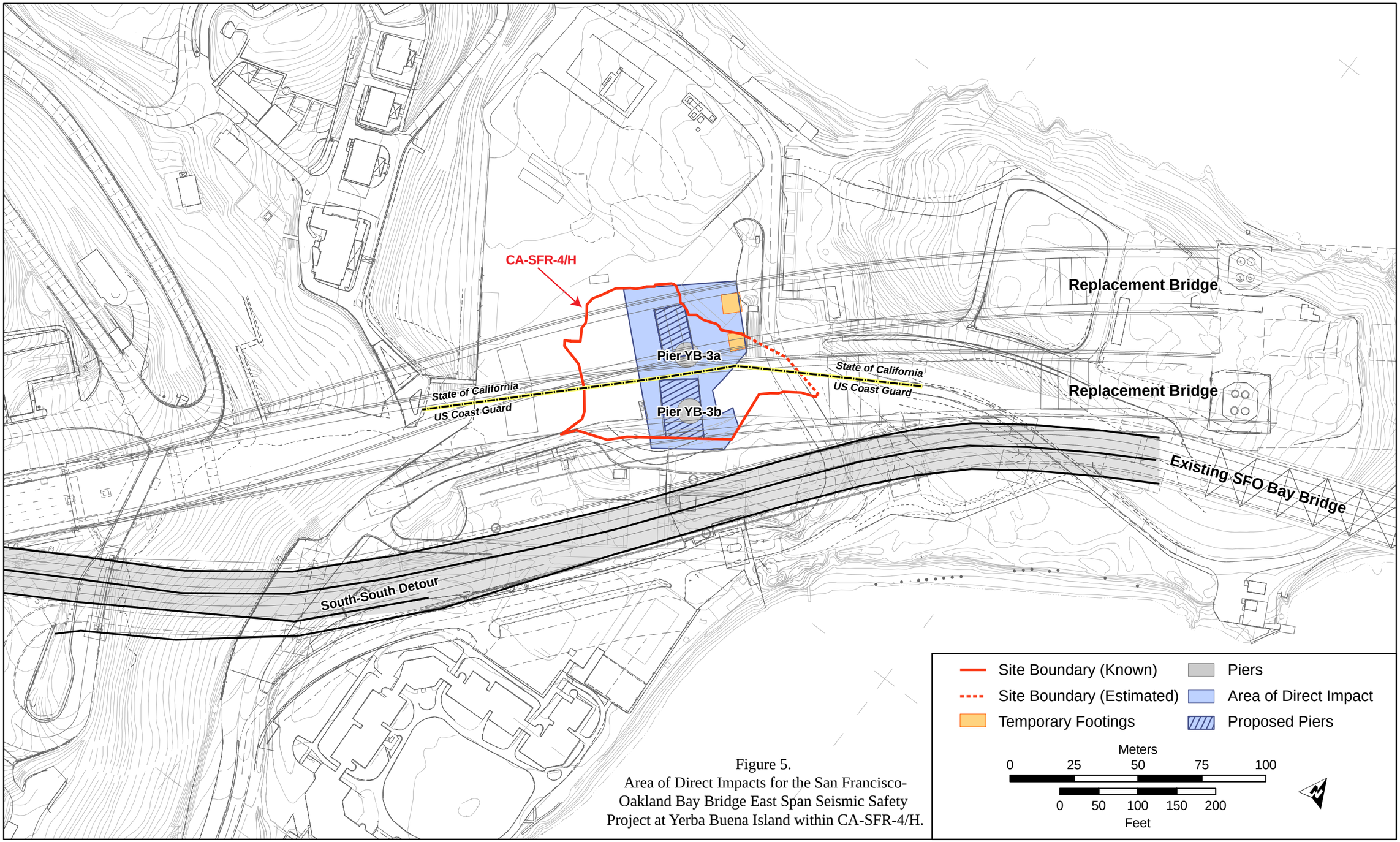


Figure 5.
Area of Direct Impacts for the San Francisco-Oakland Bay Bridge East Span Seismic Safety Project at Yerba Buena Island within CA-SFR-4/H.

PROJECT PERSONNEL

The principal authors for this study were Sally Salzman Morgan and Sean D. Dexter. Ms. Morgan holds an M.A. in anthropology (San Francisco State University) and is a Registered Professional Archaeologist with 30 years of experience in California archaeology and cultural resources management. Mr. Dexter holds a B.A. in anthropology (University of California, Santa Cruz) and has 13 years of professional experience in California archaeology and cultural resources management.

All cultural resources work on the project was carried out under the direct supervision of archaeologists who meet the Secretary of the Interior's professional qualification standards as described in *Archaeology and Historic Preservation; Secretary of Interior's Standards and Guidelines* (USDI, NPS 1983). Data recovery investigations for the prehistoric component at SFR-4/H were directed by federally qualified archaeologists with field experience in the investigation of shellmounds of the San Francisco Bay Region. Cindy Arrington was the Principal Investigator during the first field stage (M.A. in Anthropology, San Jose State University, with 13 years of experience in the field); Sally Morgan served as Principal Investigator in 2004; Sean Dexter was Field Director and Co-Principal Investigator for both phases of excavation; and Vance Benté served as Principal Investigator for historic resources (M.A. in Anthropology and 35 years of professional experience). The following individuals conducted analyses of recovered materials and prepared reports of their methods and findings:

- Dr. Dwight Simons (M.A., Zoology, University of California, Davis, 25 years' experience): Bird and Mammal Faunal Remains.
- Dr. Kenneth Gobalet (Ph.D., Zoology, University of California, Davis, 40 years' experience): Fish Remains.
- Laura Melton (M.A., Oregon State University, five years' experience): Shellfish Invertebrate Remains.
- Dr. Virgina Popper (Ph.D., Paleobotany, University of Michigan; 10 years of experience): Archaeobotanical Remains.
- William Bloomer (M.A., Archaeology, Washington State University; 20 years of experience): Flaked Stone (with contributions by Sean Dexter). Obsidian hydration and source analyses were carried out by Dr. Craig Skinner of Northwest Research Obsidian Laboratory, Corvallis, Oregon.
- Christopher Corey (B.A., Anthropology, University of Arizona; 10 years of experience): Ground Stone (with contributions by Sally Morgan).
- Dr. Randall Groza (Ph.D., Anthropology, University of California at San Francisco; 10 years of experience): Shell Beads and Ornaments.
- Dr. Randall Milliken (Ph.D., University of California, Berkeley; 31 years of experience): Shell Beads.
- Dr. Sarah Whitcher Kansa (Ph.D., Archaeology, University of Edinburgh; 15 years of experience): Human Osteology (with assistance from Eric Strother, Kathryn Entriken, Chris Corey, and Michael Thompson). DNA analyses were conducted by Lakehead University Paleo-DNA Laboratory, Ontario, Canada. All radiocarbon and nitrogen assays were conducted by Beta Analytic Laboratories in Florida.

Personnel from Far Western Anthropological Research Group, Inc., worked on finalizing the main document text, created a revised catalogue, developed and presented some interpretations, produced the final document, and organized and edited the appendices. Jeff Rosenthal, M.A., interpreted site components; Dr. Brian Byrd edited text and prepared the component summary; Pat Mikkelsen, M.A., coordinated the effort, contributed to text, and edited the document; Sharon A. Waechter, M.A. initially pulled together and edited much of the main text; and Tammara Norton, B.A., and Heather Baron, B.A., worked on graphics and report production.

SCOPE OF NATIVE AMERICAN COORDINATION

Throughout all stages of project planning and archaeological investigations, Caltrans conducted extensive consultation with local Native Americans. As per Public Resources Code 5097.98, Caltrans obtained a list of Ohlone contacts from the Native American Heritage Commission (Commission) for consultation regarding SFR-4/H. Caltrans briefed each Ohlone individual identified on the list about the project and the site, and solicited their concerns. Specifically, Caltrans sought information about cultural or descendant affiliation with individuals who might be interred on the island. The Ohlone consultants were also invited to provide input on the archaeological Research Design and Treatment Plan and to convey any concerns regarding the identification, evaluation, and treatment of human remains, associated grave goods, and items of cultural patrimony that might be uncovered. Andrew Galvan, an individual of Ohlone descent, was contracted to serve as Native American archaeological monitor for the excavations.

No individuals or groups were identified who could document direct ancestral ties to the site, but the Commission considers it as lying in either Ohlone or Coast Miwok territory. They assigned Rosemary Cambra, Chairwoman of the Muwekma Ohlone Tribe, as the Most Likely Descendant for the site. During the 2002 investigations, Ms. Cambra visited the site, viewed the human remains, and provided recommendations regarding their recovery, treatment, and re-interment (see Appendix W). She also recommended that photographic and hand-drawn representations of the human remains should be made for scientific purposes, and that human bone could be sampled for DNA and radiocarbon analyses. These recommendations contributed substantially to the research results and greatly expanded the documentation of the history of Native American occupation of Yerba Buena Island.

In 2004, excavations at SFR-4/H were restricted to federally administered lands. Federal regulations apply only to federally recognized Indian Tribes, and Caltrans encouraged the Ohlone representatives to provide any specific claims of direct lineal descent and to identify any federally recognized group who could claim cultural affiliation. The Coast Guard, as the lead federal agency for the project, also consulted with representatives of Ohlone bands who are in the process of applying for federal recognition through the Federal Bureau of Indian Affairs. As of 2006, none of the Bay Region Ohlone groups had been formally recognized by the federal government, and no living direct lineal descendants from the people who lived at SFR-4/H have been identified. None of the Ohlone groups has received formal federal recognition and, thus, none currently is afforded repatriation rights under the Native American Graves Protection and Repatriation Act. The Coast Guard does not have the authority to repatriate the remains to the Ohlone for re-interment but is consulting with the Act's Action Committee to resolve this issue. The 2004 excavations were monitored by Ohlone representatives (primarily Anne-Marie Sayers of the Indian Canyon Band of Ohlone, assisted by Chuck Striplin).

REPORT ORGANIZATION

This document first presents a contextual section, describing the site environment and regional prehistoric, ethnographic, and historical backgrounds. Project field and lab methods are described in Chapter 3. Chapters 4 and 5 deal with the prehistoric component; Chapter 4 presents relevant research issues, while Chapter 5 consists of four major sections: site stratigraphy; chronological indicators and the identification of temporal components; a summary presentation of human remains, features, artifacts, and ecofacts; and a comparative discussion of diachronic trends in resource exploitation strategies at SFR-4/H. The historic-component discussion includes a summary of artifacts and features from the American-period occupation (Chapter 6). Chapter 7 presents the site data in a regional context.

Appendices are presented at the back of this volume and include detailed descriptions of prehistoric artifacts (flaked and ground stone, beads and ornaments, and bone implements; appendices A-D) and floral and faunal remains (Appendix E). Data on human remains are presented in Appendix F, and Appendix G presents a discussion of the historic-era component, including research issues and detailed artifact descriptions.

Thereafter follows Far Western's revised and updated catalogue, which includes standardized artifact classifications and component associations (Appendix H), unit summaries (Appendix I), unit and trench profiles and descriptions (Appendix J), and site records and updates for SFR-4/H (Appendix K). Appendices L-V (on accompanying CD at back of this volume) include detailed analytical data on radiocarbon, obsidian hydration and sourcing, DNA and osteology, along with the original master catalogue and analytical data for lithics, bead, shell, bone, faunal, and historic-era analyses. Appendix W (also on the CD) is a 2002 letter from Rosemary Cambra, Chair of the Muwekma Ohlone Indian Tribe, to Cynthia Arrington, Principal Investigator, regarding discovery of human remains at CA-SFR-4/H.

Chapter 5. Findings: Prehistoric Component

This chapter presents a discussion of the prehistoric component at SFR-4/H. It begins with a presentation of stratigraphy and chronological indicators that sets up the discussion of temporal components. This is followed by a summary description of human remains recovered from the site. Then we present a general overview of features, artifacts, ecofacts, and other constituents recovered. Descriptions of all individual items are provided in the appendices to this volume.

STRATIGRAPHY (by Jeffrey Rosenthal)

Three major strata were evident in the areas excavated at SFR-4/H: a late nineteenth and early twentieth century fill overburden that included mixed historic debris, identified as Stratum I; a Middle-to-Late Period shell midden that included some intrusive historic-period material (Stratum II); and an Early Period sub-midden sand that included burials and only traces of invertebrate and vertebrate remains (Stratum III). One meter or more of sand separated the shell midden of Stratum II from the sub-midden burials associated with Stratum III. Appendix J provides stratigraphic profiles, photographs, and detailed descriptions of stratigraphy exposed in mechanical trenches and manual excavation units.

Stratum I

The uppermost stratum on the site was a fill overburden that was as much as three meters (11 feet) in depth. The fill consisted of yellowish brown sand and sandy clay, probably cut from the adjacent hill slope and used to extend the level area at the base of the hill. The fill included late nineteenth and early twentieth century materials related to military occupations of the site, as well as twentieth century construction debris and other evidence of disturbance related to construction of the Bay Bridge and later utility trenching.

Stratum II

Underlying Stratum I throughout the excavation area was a shell midden—loose, moist, black (Munsell 10 YR 2/1), organic sandy silt, with abundant fire-affected rock and a slightly greasy texture. Fish, bird, and mammal bone generally made up only a small proportion of the midden volume. Shell content—primarily finely crushed mussel, with an admixture of oyster, cockle, and various clams—was highly variable, but averaged roughly 25 percent of the soil volume. The midden also included artifacts, carbonized plant remains, and human burials.

Substrata within the midden were evident due to varying proportions of shell and sand (see Figure 9). Some lenses in the northern and central part of the site were comprised of up to 80 to 90 percent shell by volume, while other substrata were composed mainly of dark-colored sand with shell concentrations of less than five percent (see Appendix J for detailed descriptions of hand units and trenches). These substrata were not continuous over large areas of the site, tended to overlap and merge, and often could only be discerned in the unit profile following excavation.

Several discrete shell midden substrata were noted in Trench AA/DD, in the southern area of the site. These were sampled to assess whether they had distinctive contents. However, further investigation and stratigraphic analysis suggested that these apparently discrete strata were bi-products of midden erosion and slumping at the edge of the East Cove bluff, and represent secondary deposition.

The midden of Stratum II varied from a few centimeters to 130 centimeters (4.25 feet) thick within the area excavated. It was thickest in the west-central part of the excavation area, and thinned to the north, south, and east (see Figure 13). Auger results from 1998 suggest that the midden stratum may be thickest in the western portion of the site, outside the project ADI.

In all excavated areas, the midden stratum had diminishing amounts of shell with depth and also became more clayey and compact, in some places grading from nearly black to a very dark gray color (Munsell 10YR 3/1). There was abundant evidence of historic and modern disturbance in the midden stratum, including historic grading and redeposition, particularly in the upper part of the deposit, but also as deeper intrusions. In most of the midden, however, the generally good integrity of burial features indicates that the strata were essentially intact.

At the base of the midden stratum was a layer of olive brown silty sand (variously described as Munsell 2.5 YR 5/3 to Munsell 10 YR 6/3), with sparse flecks of shell. This stratum was lighter in color than the overlying shell midden, but darker in color than the underlying sand. The color of the stratum was interpreted as derived from organic material leached from the overlying midden, and the stratum therefore was described as "midden-stained sand." This deposit, consistently about 20 to 30 centimeters (8 to 12 inches) thick, contained little cultural material; however, a few burial pits extended into or through it. Most or all of these burials were interpreted as associated with Stratum II, based on the presence of shell midden in the burial pits. The midden-stained deposit therefore is considered a substratum of the overlying shell midden.

Stratum III

The basal cultural stratum of the site, Stratum III, consisted of moderately consolidated, medium-grained sand, which ranged in color from dark yellowish brown (Munsell 10 YR 4/4), to yellowish brown (10 YR 5/4), to pale brown (10 YR 6/3). Stratum III probably represented sand dunes that lay on the bluff adjacent to East Cove, and is described in field records as the "sub-midden dune deposit" or "deep sub-midden sand." Human burials and directly associated grave goods were the primary cultural contents recovered from this stratum. However, it was not widely sampled except for basal levels of some hand-excavated control units (Figure 14; Figure 15). The sub-midden dune deposit was about two meters (6.5 feet) thick along the southern margin of the site, and possibly somewhat thinner to the north. The sand dune stratum revealed relatively little stratigraphic disturbance. However, there was evidence of a few rodent burrows in the upper part of the stratum; depositional slumping and erosion of Stratum III were evident along the southern margin of the site; and some areas of intrusive excavation associated with the construction of Macalla Road, the Coast Guard entry station, and Bay Bridge pilings YB-3A and 3b were evident.

Burials were found in Stratum III throughout the excavation area. They were recovered at depths ranging from 50 to about 150 centimeters (19 to ~60 inches) below the base of the shell midden (Stratum II), separated from the overlying stratum by culturally sterile sand. In most cases, distinct burial pits were discernable in the sand stratum by a distinctly "pinkish" cast (Munsell 5 YR 4/6, yellowish-red), although the fill was identical in texture to the surrounding matrix. None of these burial pits included midden or midden-stained sand.

Stratum III grades at its base into a very compact, yellowish brown sand (Munsell 10 YR 5/6, yellowish brown), which is increasingly compact with depth. This appears to be the basal sub-dune B horizon of the site. This substrate had no cultural content.

CHRONOLOGICAL INDICATORS (by Jeffrey Rosenthal)

Chronological indicators from SFR-4/H were varied and abundant. Radiocarbon dates were obtained from 27 samples recovered during archaeological excavations; obsidian hydration rim measurements were taken on 67 artifacts; and there were over 1,500 temporally diagnostic beads and ornaments, two projectile points, and several charmstones.

Radiocarbon Data

Radiocarbon analysis included seven samples of charcoal from sequential levels in shell midden excavation units, two samples of charred material found in association with burials, human bone collagen from 12

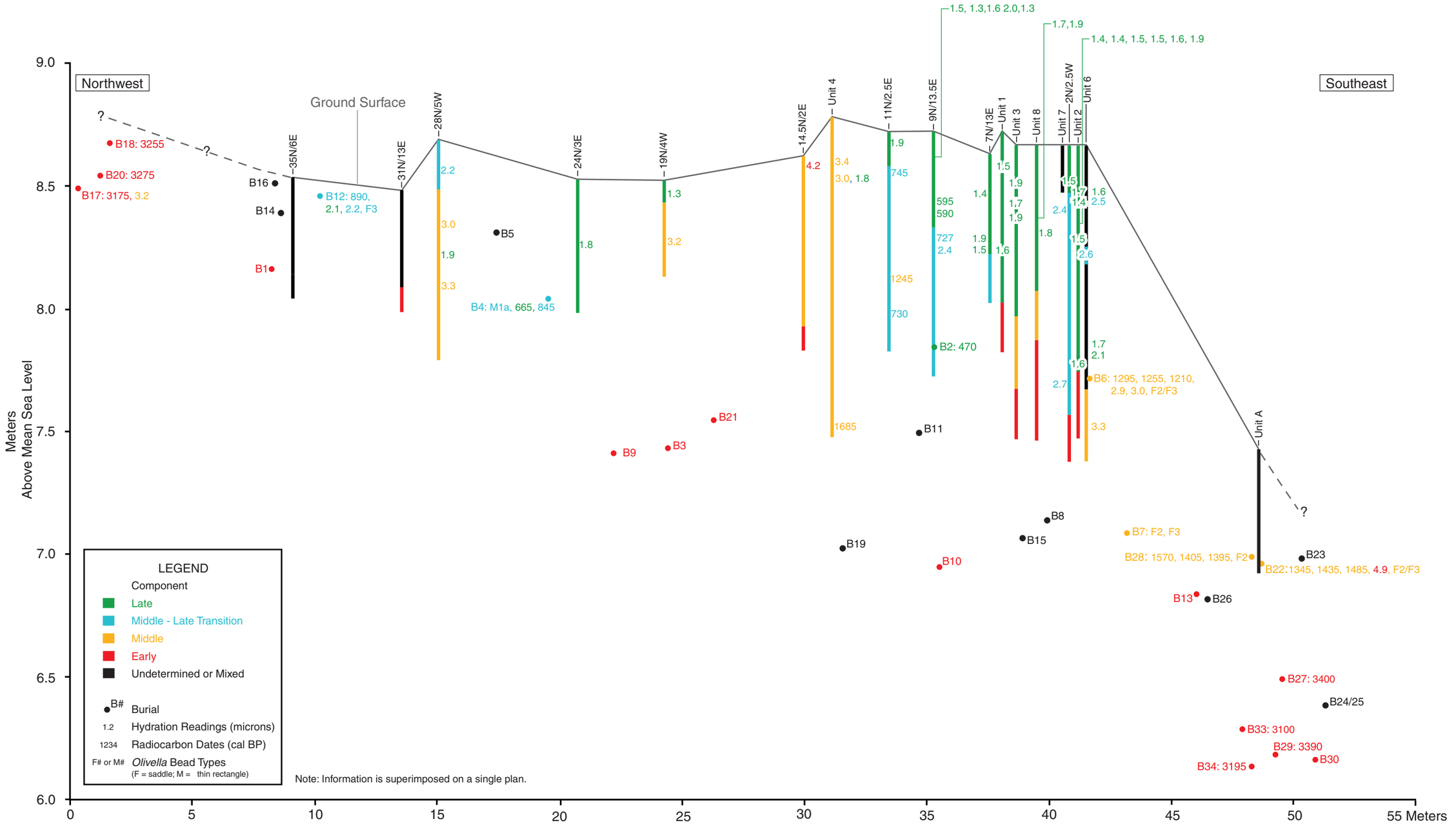


Figure 14. Spatial Distribution of Site Components and Burials at SFR-4/H.

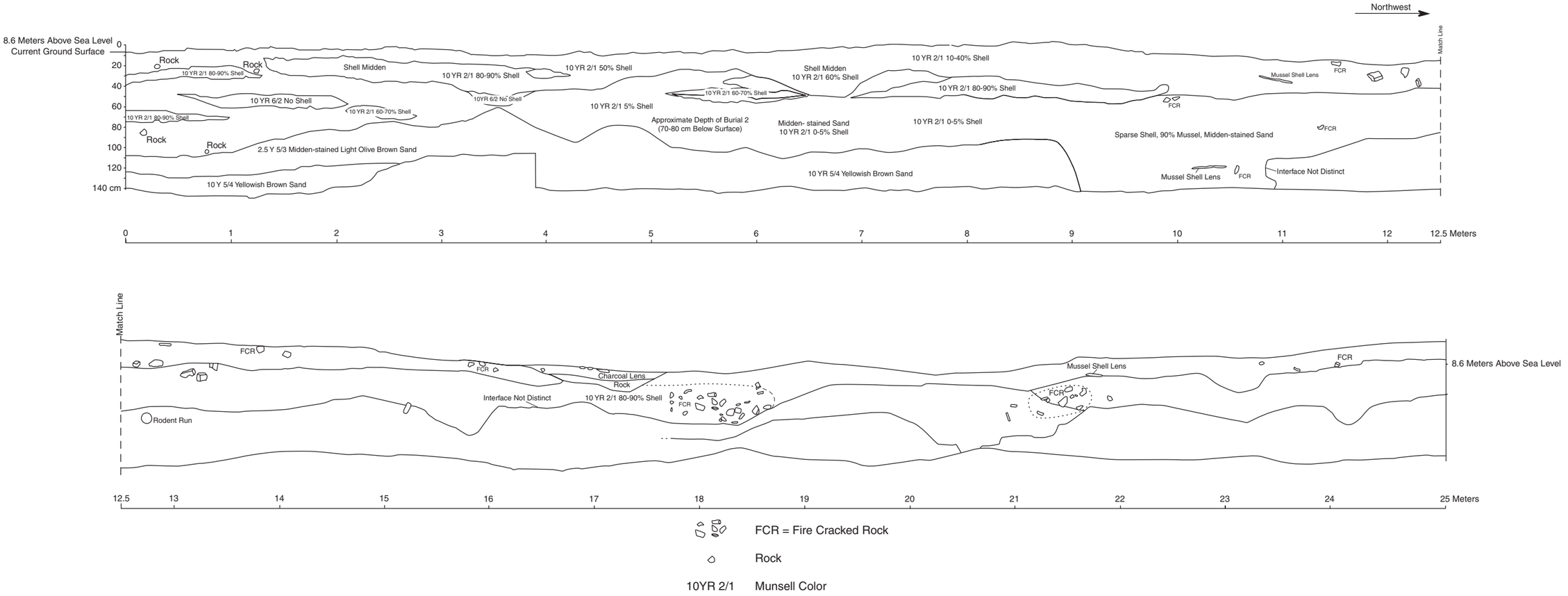


Figure 15. Stratigraphic Profile of Shell Midden Exposed in Trench B, Western Wall, at SFR-4/H.

Table 4. Radiocarbon Dates for CA-SFR-4/H: Beta Analytic and CALIB Calibrations and Bead Horizon Placement.

Beta Analytic Sample No.	Provenience			Material Dated	Beta Analytic Calibration			CALIB 5.0.2 Calibrations (Δ260+/135)	
	Unit/ Burial No.	Associated Context	Level or Elevation		Beta 2 Sigma Calibration (cal BP)	13C/12C Ratio	N15/N14 Ratio	2 Sigma CALIB Date (cal BP)	Median Probability (cal BP)[a]
172574	4	Shell midden	120-130 cm	charcoal	1810-1570	-25.3	-	1570-1583, 1596-1816	1685
172575	9N/3.5E	Shell midden	20-30 cm	charcoal	660-510	-24.0	-	514-657	595
172576	9N/3.5E	Shell midden	30-40 cm	charcoal	670-490	-24.8	-	495-677	590
172577	9N/3.5E	Shell midden	40-50 cm	charcoal	890-860, 800-660	-25.2	-	657-802, 810-830, 858-904	725
172578	11N/2.5E	Shell midden	10-20 cm	charcoal	920-720	-25.9	-	736-916	745
172579	11N/2.5E	Shell midden	50-60 cm	charcoal	1300-1170	-23.6	-	1172-1303	1245
172580	11N/2.5E	Shell midden	70-80 cm	charcoal	790-660	-25.4	-	666-798, 815-823, 869-899	730
172581	Burial 4	Shell midden	8.06 ASL	charcoal	930-740	-24.8	-	743-754, 759-923	845
172582	Burial 2	Shell midden	67 cm/ 7.38 ASL	charcoal	520-430, 380-320	-23.7	-	319-392, 426-523	470
173475	Burial 4	Shell midden	8.06 ASL	human bone collagen	1310-1230, 1210-1190	-11.7	-	553-756	665
173476	Burial 6	Shell midden	1.05 cm/ 7.75 ASL	human bone collagen	-	-11.8	-	1186-1202, 1226-1377	1295
177103	Burial 6	Shell midden	7.75 ASL	*Olivella* shell bead	1370-1210	+0.6	-	1140-1359	1255
177104	Burial 6	Shell midden	7.75 ASL	*Olivella* shell bead	1320-1160	+0.7	-	1076-1301	1210
196491	Burial 22	Shell midden	7.00 ASL	human bone collagen	1250-970	-15.7	-	1265-1449, 1453-1485	1345
197487	Burial 22	Shell midden	7.00 ASL	*Olivella* shell bead	1590-1360	-0.2	-	1307-1554	1435
197488	Burial 22	Shell midden	7.00 ASL	*Olivella* shell bead	1670-1410	-0.5	-	1348-1626	1485
197489	Burial 28	Shell midden	7.04 ASL	*Olivella* shell bead	1540-1320	+0.1	-	1287-1514	1395
197490	Burial 28	Shell midden	7.04 ASL	*Olivella* shell bead	1550-1330	+0.7	-	1291-1521	1405
196493	Burial 28	Shell midden	7.04 ASL	human bone collagen	1690-1390	-12.5	+17.9	1406-1712	1570
173477	Burial 12	Shell midden	8.49 ASL	human bone collagen	1540-1350	-12.3	-	762-1010	890
173478	Burial 17	Sub-midden	8.5 ASL	human bone collagen	3830-3620	-13.6	-	3022-3325	3175
175605	Burial 18	Sub-midden	8.68 ASL	human bone collagen	3910-3700	-13.1	-	3106-3373	3255
175606	Burial 20	Sub-midden	8.55 ASL	human bone collagen	3900-3700	-13.5	-	3132-3386	3275
196492	Burial 27	Sub-midden	6.52 ASL	human bone collagen	3420-3150	-13.4	+17.5	3261-3547	3400
196494	Burial 29	Sub-midden	6.23 ASL	human bone collagen	3420-3150	-13.3	+19.0	3254-3542	3390
196495	Burial 33	Sub-midden	6.32 ASL	human bone collagen	3170-2780	-13.2	+16.6	2917-3306	3105
196496	Burial 34	Sub-midden.	6.17 ASL	human bone collagen	3270-2880	-13.4	+18.7	3000-3359	3195

Notes: [a] - Date used for component analysis; ASL – above sea level.

burials (with permission from the Most Likely Descendant, Rosemary Cambra), and six burial-associated *Olivella* shell beads. Of these 27 dates, 11 derive from the same four burial contexts (Burials 4, 6, 22, and 28). Radiocarbon data are detailed in Table 4 and complete data are presented in Appendix L.

All radiocarbon samples were processed by Beta Analytic, Inc. However, as the samples were submitted in several batches, by several researchers over a period of three years, there is some variability in calibration scenarios provided by Beta Analytic. To ensure consistency, the conventional radiocarbon ages provided by Beta Analytic were all calibrated in 2007 using the CALIB 5.0.2 on-line radiocarbon calibration program (Stuiver et al. 2006). This calibration uses varying data sets for terrestrial and marine-derived carbon. Samples of charred material from the midden are assumed to be of terrestrial origin, and were calibrated using the IntCal04 data set (Stuiver and Reimer 1993). Shell bead dates were calibrated using the Marine04 data set (Hughen et al. 2004) and a marine reservoir correction of 260±35. Calibrations for human bone samples used the Mixed Marine Northern Hemisphere data set (Hughen et al. 2004), also with a marine reservoir correction of 260±35 years. Proportion of the marine diet was estimated for each individual based on a matrix of 13C/12C ratios and (where available for samples) 15N/14N ratios (see Appendix L) for further discussion of calibrations). Compared to other central California burial populations, both the carbon and nitrogen values from bone collagen at SFR-4/H suggest diets high in marine foods (c.f., Bartelink 2006; Bouey 1995). As a result, marine carbon corrections ranged from approximately 50% to 98% (Table 5).

Table 5. Comparison of Radiocarbon Dates from Burial Contexts.

Burial #	Material	Marine Correction	Date cal BP
4	Charcoal	0%	845
	Bone Collagen	98%	665
6	*Olivella* shell	100%	1210
	Olivella shell	100%	1255
	Bone Collagen	97%	1295
22	*Olivella* shell	100%	1435
	Olivella shell	100%	1485
	Bone Collagen	56%	1345
28	*Olivella* shell	100%	1405
	Olivella shell	100%	1395
	Bone Collagen	89%	1570

Calibrated radiocarbon dates from SFR-4/H fall into three discrete groupings dating to the Early and Middle periods, and to the Middle/Late Transition/early Late period (Figure 16).

The earliest cluster of seven dates (median probability, 3400-3105 cal BP) spans a 300-year interval during the central California Early Period (Bennyhoff and Hughes 1987; Groza 2002; Milliken et al. 2007). These dates all derive from bone collagen sampled from burials recovered from the site's sub-midden.

Separated from the earlier assays by approximately 1,400 years, the second grouping of 11 dates (median probability, 1685-1210 cal BP) clusters within a 475-year interval, from the Early Phase to the Late Phase of the Middle Period (Figure 16). Just two of these assays fall at the end of Early Phase of the Middle Period (median probability, 1685-1570 cal BP), while the other nine dates occur within a 275-year interval (median probability, 1485-1210 cal BP) spanning the Intermediate and Late Phases of the Middle Period (Figure 16). Nine of the 11 Middle Period dates derive from three burial contexts and were obtained from either bone collagen (n=3), or *Olivella* shell beads (n=6). The other two were obtained from shell midden charcoal in the 120-130-centimeter level of Unit 4 (Beta-172574) and the 50-60-centimeter level of Unit 11N/2.5E (Beta-172579).

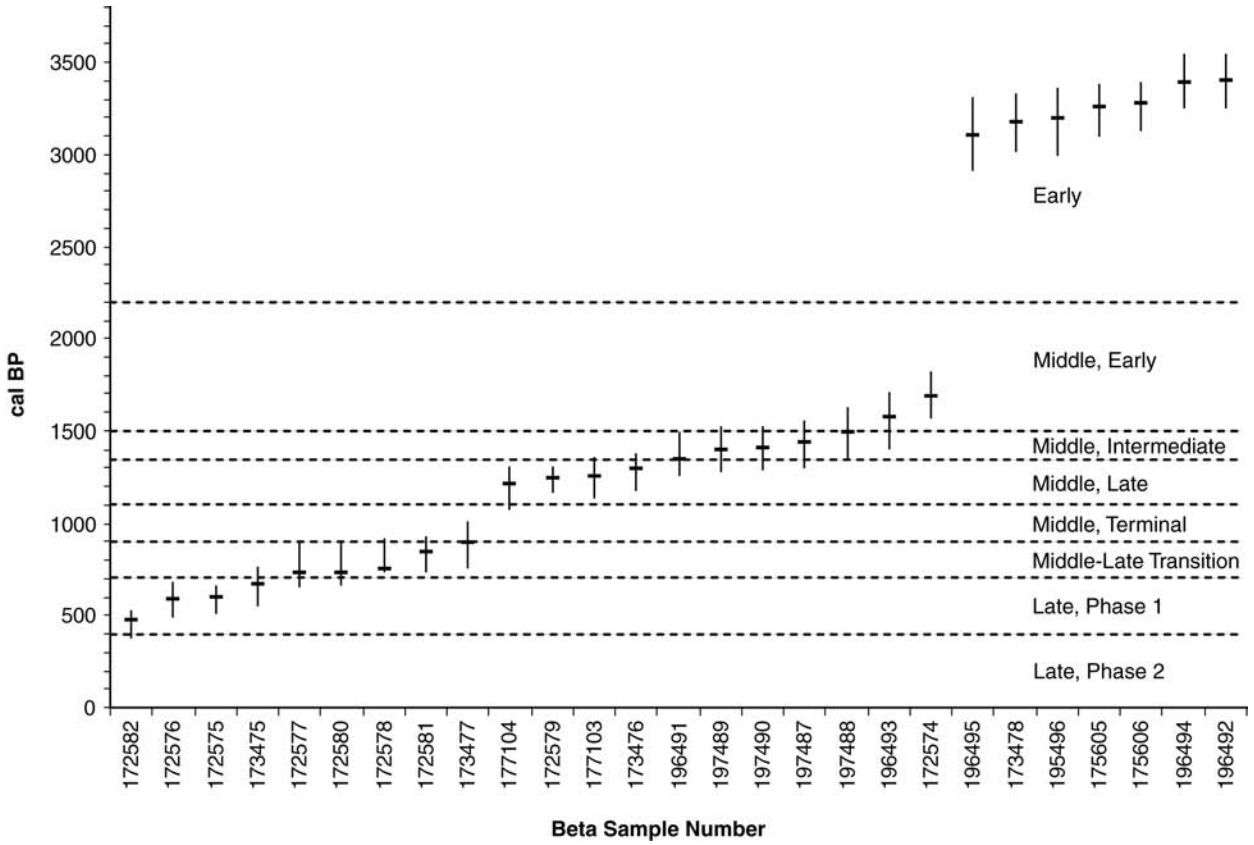


Figure 16. Comparison of Radiocarbon Dates from SFR-4/H with the Central California Chronology.

The last series of nine dates (median probability, 890-470 cal BP) clusters within a 420-year interval during the Middle-Late Period Transition and Phase 1 of the Late Period. They are separated in time from the Middle Period grouping by a span of 320 years, perhaps reflecting an occupational hiatus during the Terminal Phase of the Middle Period (i.e., 1150-900 cal BP). All but the most recent (470 cal BP) of these younger dates occur within a comparatively short 300-year interval (median probability, 890-590 cal BP), from the Middle-Late Transition to the very beginning of the Late Period. The majority (n=5) of these nine dates originated from charcoal collected in the shell midden; two others are from charcoal associated with Burials 2 and 4; and two are from bone collagen originating from Burials 4 and 12.

It should be noted that, in three instances where multiple radiocarbon dates were obtained on different kinds of organic material from the same burial context, there is a poor correspondence between the resulting dates (see Table 5). Where multiple *Olivella* shells and bone collagen were dated from the same burial, the shell samples always produced complimentary dates (between ten and 50 years divergence), whereas the bone collagen produced dates either significantly older (as much as 165 years) or younger (as much as 140 years) than those obtained from the shell (see Table 5). Only shell and collagen samples from Burial 6 produced complementary dates.

One obvious influence on these results is the reservoir correction applied to the collagen dates. Although the shell dates were also calibrated for marine reservoir effect, correction for the bone varied between samples based on an estimated amount of marine food in the diet (see Appendix N for rationale and details). For collagen samples from Burials 6 and 28 to produce calibrated dates more closely corresponding to those from associated *Olivella*, a correction factor assuming 100% marine food would be necessary (e.g., Burial 6 would calibrate to 1248 BP and Burial 28 to 1488 BP; see Table 5). Instead, these samples were calibrated assuming

diets of 97% and 89%, respectively, based on their carbon and nitrogen ratios. On the other hand, just a 35% marine correction would need to be applied for the collagen date from Burial 22 to correspond to the shell dates from that context (i.e., 1465 cal BP). Without additional information, we assume the consistent shell dates from these three burials to be the most reliable.

Obsidian Hydration and Source Data

The Northwest Research Obsidian Studies Laboratory conducted XRF source analysis and obsidian hydration measurements on 67 pieces of obsidian from SFR-4/H; these included 28 tools and 39 flakes (Table 6; see Appendix M for detailed data). The majority of specimens (n=60; 90%) originated from the Napa Valley source (~65 miles north of San Francisco Bay), while five are from the Annadel quarry in Santa Rosa, one is from Mt. Konocti near Clear Lake, and one is from Bodie Hills, located east of the Sierra Nevada crest. The sample produced 62 viable hydration readings: six specimens showed no visible hydration band (three Napa, one Mt. Konocti, and two Annadel), while one biface and one flake had double rims (Table 6).

Table 6. Obsidian Hydration Data from SFR-4/H.

Cat #	Unit	Depth (cm)	Description	Flake Type	Rim 1	Rim 2	Source
577	Historic Feature 2	0-10	Biface	-	1.0		Napa Valley
628	Quadrant 4	Midden, upper 2 feet	Drill	-	1.5		Napa Valley
826	Unknown	Surface	Biface	-	2.2		Napa Valley
6	1	0-10	Biface	-	NA		Napa Valley
11	1	10-20	Projectile Point	-	1.5		Napa Valley
1035	1	50-60	Flake	cort	1.6		Napa Valley
38	2	0-10	Flake	sf	1.7		Annadel
44	2	10-20	Flake	pp	1.7		Napa Valley
1037	2	20-30	Biface	-	1.4		Napa Valley
49	2	20-30	Flake	sint	2.5		Napa Valley
53c	2	30-40	Flake	ebt	1.4		Napa Valley
53e	2	30-40	Flake	bp	1.4		Napa Valley
53d	2	30-40	Flake	lbt	1.5		Napa Valley
53b	2	30-40	Flake	sintcp	1.5	5.5	Napa Valley
53a	2	30-40	Flake	cort	1.6		Napa Valley
1038	2	30-40	Biface	-	1.9		Napa Valley
58	2	40-50	Flake	sint	1.5		Napa Valley
68	2	80-90	Flake	cint	1.6		Napa Valley
98	3	Surface	Projectile Point	-	2.5		Bodie Hills
81	3	10-20	Flake	sint	1.9		Napa Valley
84	3	20-30	Flake	cort	1.7		Napa Valley
86	3	30-40	Flake	sint	1.9	3.1	Napa Valley
114	4	10-20	Biface	-	3.4		Napa Valley
120	4	20-30	Biface	-	1.8		Napa Valley
119	4	20-30	Flake	emf	3.0		Napa Valley
148	4	110-120	Flake	lpr	NA		Annadel
336	6	10-20	Biface	-	1.6	3.2	Napa Valley
348	6	50-60	Biface	-	2.6		Napa Valley
355	6	70-80	Biface	-	1.7		Napa Valley
361	6	80-90	Flake	sint	2.1		Napa Valley
368	6	110-120	Biface	-	3.3		Napa Valley

Table 6. Obsidian Hydration Data from SFR-4/H *continued*.

Cat #	Unit	Depth (cm)	Description	Flake Type	Rim 1	Rim 2	Source
528	8	30-40	Biface	-	1.7		Napa Valley
529	8	30-40	Biface	-	1.9		Napa Valley
533	8	40-50	Biface	-	1.8		Napa Valley
474	2N/2.5W	10-20	Biface	-	1.5		Napa Valley
483	2N/2.5W	20-30	Biface	-	2.4		Napa Valley
507	2N/2.5W	100-110	Flake	sint	2.7		Napa Valley
162b	7N/13E	10-20	Flake	ep	NA		Napa Valley
162a	7N/13E	10-20	Flake	sintcp	1.4		Napa Valley
162c	7N/13E	10-20	Flake	sint	NA		Napa Valley
173	7N/13E	30-40	Flake	lbt	1.9		Napa Valley
178	7N/13E	40-50	Flake	lbt	1.5		Napa Valley
395	9N/3.5E	0-10	Core	-	1.5		Napa Valley
396c	9N/3.5E	0-10	Flake	pp	1.3		Napa Valley
396a	9N/3.5E	0-10	Flake	lbt	1.6		Napa Valley
396b	9N/3.5E	0-10	Flake	lbt	2.0		Napa Valley
403	9N/3.5E	10-20	Flake	sf	1.3		Napa Valley
418	9N/3.5E	60-70	Biface	-	2.4		Napa Valley
433	11N/ 2.5E	0-10	Flake	ep	1.9		Napa Valley
228	14.5N/2E	0-10	Biface	-	4.2		Napa Valley
193	19N/4W	0-10	Core	-	1.3		Napa Valley
197	19N/4W	20-30	Flake	pp	3.2		Napa Valley
225	24N/3E	20-30	Biface	-	1.8		Napa Valley
266b	28N/5W	0-20	Flake	lbt	1.3		Annadel
266a	28N/5W	0-20	Flake	lbt	2.2		Napa Valley
276a	28N/5W	30-40	Flake	lbt	2.3		Annadel
1433	28N/5W	30-40	Biface	-	3.0		Napa Valley
280a	28N/5W	40-50	Flake	cint	1.9		Napa Valley
283	28N/5W	50-60	Flake	lbt	3.3		Napa Valley
301	28N 5W	80-90	Flake	lbt	NA		Annadel
881a	Burial 6	7.75 above sea level	Flake	cort	NA		Mt. Konocti
882	Burial 6	"	Flake	emf	2.9		Napa Valley
881b	Burial 6	"	Flake	lpr	3.0		Napa Valley
846	Burial 12	8.49 above sea level	Biface	-	2.1		Napa Valley
845	Burial 12	"	Biface	-	2.2		Napa Valley
861	Burial 17	8.5 above sea level	Flake	emf	3.2		Napa Valley
1533	Burial 22	7.00 above sea level	Biface	-	4.9		Napa Valley

Notes: Flake types: cort – cortical; sf – simple fragments; pp – platform preparation; sint – simple interior; sisntcp - simple interior/complex platform; ebt – early biface thinning; bp – bipolar; lbt – late biface thinning; cint – complex interior; emf – edge modified flake; lpr – late pressure; ep – edge preparation.

As indicated in Table 7, the hydration sample of 57 Napa Valley specimens returned a mean value of 2.1 microns with a range of 1.0-4.9 microns (Table 7). A mean of 1.8 microns was obtained from the three viable

Annadel readings, while the single Bodie Hills specimen produced a reading of 2.3 microns. Using Origer's (1982) hydration conversion for Napa Valley obsidian, the majority of this material appears to have been deposited at the site between the Middle Period and the beginning of Phase 2 of the Late Period. Two samples also produced Early Period values, but the largest reading (4.9µ) is a statistical outlier using Chauvenet's Criterion (Figure 17) and was associated with a well-dated Middle Period burial.

Table 7. Summary of Obsidian Hydration Results by Source from SFR-4/H.

Source	Mean (µ)	Median (µ)	Ct.	Range (µ)	S.D.	C.V.
Napa	2.1	1.9	57	1.0-4.9	0.78	0.37
Annadel	1.8	1.7	3	1.3-2.3	0.5	0.28
Bodie	2.5	-	1	-	-	-
Mt. Konocti	n/a	-	1	-	-	-
Notes: µ – microns; Ct. – count; S.D. – Standard Deviation; C/V - Coefficient of Variation.						

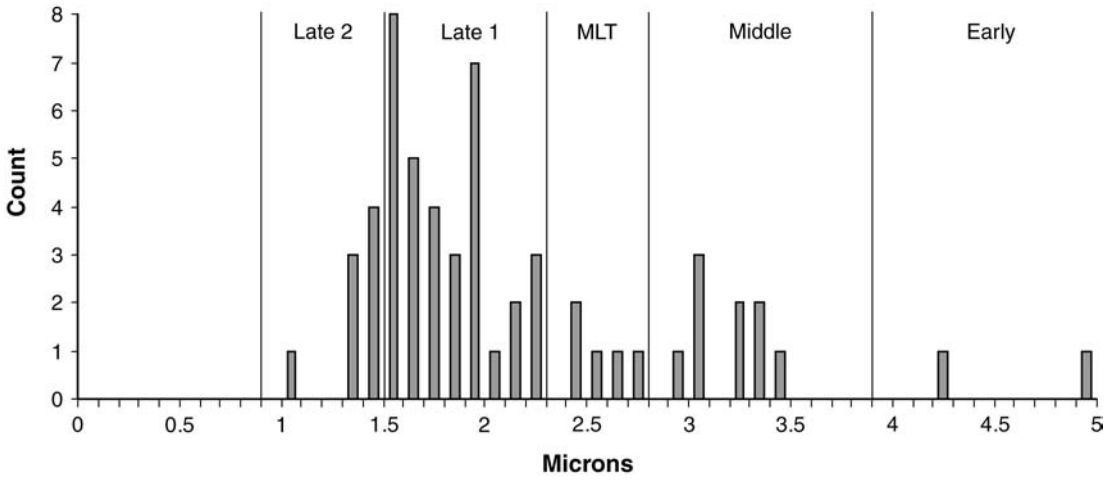


Figure 17. Napa Valley Obsidian Hydration Results from SFR-4/H.

Temporally Diagnostic Artifacts

Temporally diagnostic artifacts from the prehistoric component at SFR-4/H include shell beads and ornaments, projectile points, and charmstones.

Olivella Shell Beads

The most chronologically diagnostic artifacts found in the shell midden stratum at SFR-4/H are *Olivella* shell beads, analyzed for this study by Randall Groza and Randall Milliken (Appendix C). Some 1,548 temporally diagnostic *Olivella* beads were recovered during excavations, all but one from mortuary contexts (burials 4, 6, 7, 12, 22, and 28). An additional three were non-diagnostic A1 spire-lopped forms, along with 271 untypable fragments (Table 8).

Olivella shell bead types at SFR-4/H are classified here according to the Bennyhoff and Hughes typology of 1987, with modification and expansion of the *Olivella* "Saddle" class based on a new typological definitions developed by California shell bead specialists at a workshop in 2003. We emphasize two subtypes of *Olivella* "saddle" beads that were delineated by Bennyhoff and Hughes but never used by them in the process of their temporal phase delineation. Secondly, we reject their "fuzzy sets" of saddle bead subtypes (caused by

Table 8. *Olivella* Shell Beads by Location and Type.

Location	Depth ASL	URS Cat. Number.	Spire-lopped		Untyp Frag	Wall Beads										Total
						Sequins		Saucers	Wide Saddles			Narrow Saddles				
			A1B	A1C		M1A	M1D	G1	F2A	F2B	F2C/D	F3A2	F3B2	F3A	F3B	
Burials																
Burial 4	8.06 m asl	-0855	-	-	-	1,094	6	-	-	-	-	-	-	-	-	1,100
Burial 6	7.75 m asl	-0866	-	-	239	-	-	30	-	-	12	76	6	77	19	459
Burial 7	7.12 m asl	-0843	-	-	32	-	-	-	4	17	14	8	-	-	-	75
Burial 12	8.49 m asl	-0860	-	-	-	-	-	-	-	-	-	-	-	8	-	8
Burial 22	7.00 m asl	-1478	-	-	-	-	-	-	14	12	37	8	-	2	-	73
Burial 28	7.04 m asl	-1542	-	-	-	-	-	-	21	16	66	-	-	-	-	103
Total Beads with Burials			*0*	*0*	*271*	*1,094*	*6*	*30*	*39*	*45*	*129*	*92*	*6*	*87*	*19*	*1,818*
Units																
Unit 6	10-20 cm bsl	-0335	1	-	-	-	-	-	-	-	-	-	-	-	-	1
19N/4W	10-20 cm bsl	-0194	-	1	-	-	-	-	-	-	-	-	-	-	-	1
28N/5W	70-80 cm bsl	-0295	1	-	-	-	-	-	-	-	-	-	-	-	-	1
35N/6E	0-10 cm bsl	column sample	-	-	-	1	-	-	-	-	-	-	-	-	-	1
Total Beads in Units			*2*	*1*	*0*	*1*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*4*
Total Beads Recovered			2	1	271	1,095	6	30	39	45	129	92	6	87	19	1,822

Notes: ASL – Above Sea Level; BSL – Below surface level; Untyp Frag – Untypable Fragment.

overlapping metric definitions) in favor of rigorous metric differentiation of types. This report uses the recently-developed time brackets of Dating Scheme D2 (see Table 1; Groza 2002; Hughes and Milliken 2007:262-268; Milliken et al. 2007).

Twelve different types or subtypes of *Olivella* shell beads were recovered during excavations at SFR-4/H. These represent Class A (Spire-lopped; occur throughout prehistory), Class F (Saddle), Class G (Saucer), and Class M (Sequin Rectangle) in the Bennyhoff and Hughes (1987) typology (Table 8; Figure 18). They are discussed here by burial bead lots, and detailed in Appendix C.

Approximately 1,094 *Olivella* M1a beads were recovered in association with Burial 4. The grave bead lot also included six M1d Wide Sequins. Radiocarbon dates and bead seriation suggests, therefore, a Middle/Late Transition placement, 900 to 700 cal BP.

Only 220 of 459 *Olivella* beads recovered from Burial 6 could be identified to type, with 190 representing a mixture of smooth-edged saddle beads (93 percent subtypes F3a, F3b, F3a2, and F3b2; six percent bisymmetric Wide Saddles F2c/d). Besides the saddles, the grave lot included 30 distinct *Olivella* G1 Tiny Saucers. This array of (predominately) modified saddles with some saucers seriates to the Late Middle Period, 1350 to 1100 cal BP, and is consistent with the three radiocarbon assays from this context (i.e. cal BP 1210, 1255, 1295; Table 9).

Table 9. Burial Associated Shell Bead Lots and Other Chronological Information.

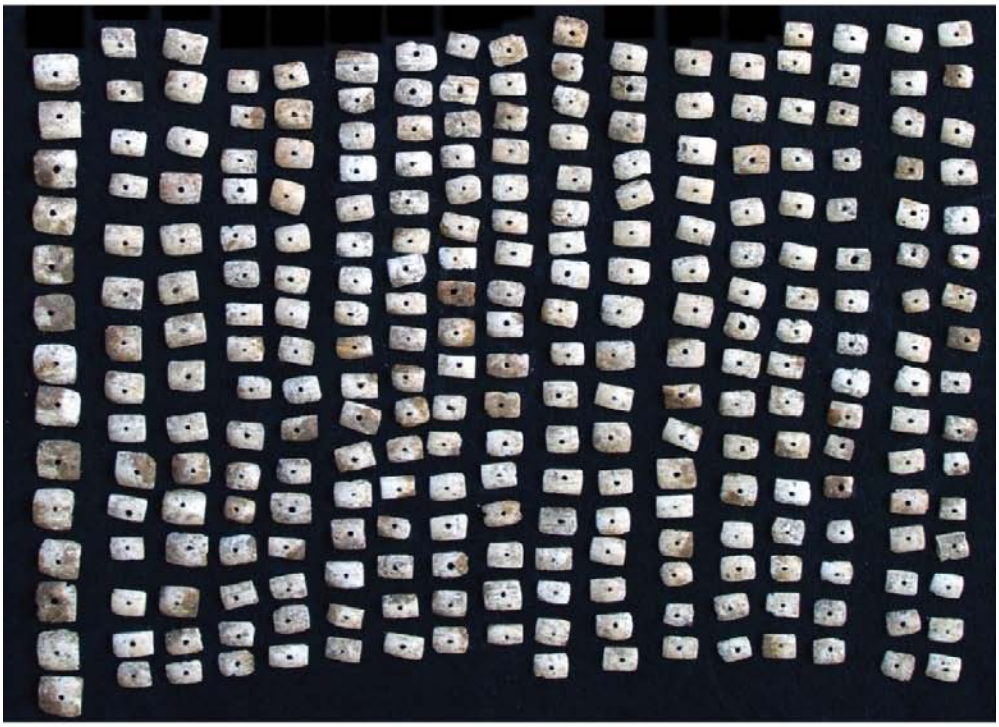
Burial #	Obsidian Source	Hydration Readings	Mean (µ)	14C cal BP	Beads
4	-	-	-	-	M1a (1094), M1d (6)
12	Napa Valley	2.1, 2.2	2.2	890	F3 (8)
6	Napa Valley	2.9, 3.0	3.0	1210, 1255, 1295	G1 (30), F2c/d (12), F3 (178)
22	Napa Valley	4.9	4.9	1345, 1435, 1485	F2 (26), F2c/d (37), F3 (10)
7	-	-	-	-	F2 (21), F2c/d (14), F3 (8)
28	-	-	-	-	F2 (37), F2c/d (66)

The 103 *Olivella* beads recovered in association with Burial 28 are all Class F Saddles. The range of forms includes F2c/d bisymmetrical Wide Saddles (64 percent), F2a Full Saddles (20 percent), and F2b Rounded Saddles. They all have chipped edges. Two beads from this population have been directly dated, yielding calibrated median probabilities of 1405 cal BP (Beta-197490) and 1395 cal BP (Beta-197489). This places these beads as temporally equivalent to a number of dated smooth-edged mixed wide and narrow saddle bead lots that mark the Intermediate Middle Period (1520 to 1350 cal BP). Human bone collagen from this burial (Beta-196493) yielded an earlier date of 1570 cal BP, which, as previously discussed, is not consistent with the bead dates. Napa Valley obsidian hydration readings of 2.9 and 3.0µ were obtained from debitage associated with Burial 6. Using Origer's (1982) hydration rate model, these translate to calibrated radiocarbon years of 1290 and 1380; largely consistent with other chronological information from this context, indicating an Intermediate Middle Period date.

Burial 7 was accompanied by 75 *Olivella* beads; only 43 beads could be typed, all as Class F Saddles. They were a clinal array of F2b Rounded Saddles with chipped edges (n=17), F2c/d bisymmetric Wide Saddles (n=14), F3a2 Rounded Narrow Saddles with chipped edges (outliers of F2b; n=8), and F2a Full Saddles with chipped edges (n=4). Overall, the array represents an F2b Rounded Saddle bead lot of the Intermediate Middle Period.

The 75 *Olivella* beads with Burial 22 are all chipped edge Class F Saddles; 48 were measured and identified as predominately F2c Rectanguloid Wide and F2d Elliptic Wide Saddles (n=24), grading into F2a Full

G1 Saucers, F2 Wide Saddle, and F3 Narrow Saddle.



M1 Sequins

Figure 18. Selected Beads from SFR-4/H Burials.

Saddles (n=9), F2b Round Saddles (n=8), and F3a Narrow Saddles (n=7). Two beads from this population have been directly dated (see Table 9) generating dates of 1435 and 1485 cal BP falling within the Intermediate Middle Period. This assignment conforms well to the expected age of the Saddle bead mix from this context. However, a single Napa Valley hydration reading of 4.9µ obtained on a biface associated with Burial 22 (see Table 9) translates to a calibrated age of 3680 cal BP. This date is more than twice as old as expected, given the associated bead types and radiocarbon determinations. As noted above in the *Obsidian Hydration and Source Data* discussion, this particular reading is a statistical outlier in the hydration sample from the site and appears to represent either an heirloom or measurement of an older, pre-existing surface on the tool.

The eight *Olivella* shell beads recovered with Burial 12 are all smooth edged F3a square Narrow Saddles. They are all highly eroded and rather rounded. This pure modified saddle lot may represent the M3 Bead Horizon (Late Middle Period), but its associated radiocarbon date of 890 cal BP places it within the Middle-Late Transition period (900 to 700 cal BP). Two Napa Valley obsidian hydration readings from this context (2.1 and 2.2µ; see Table 9) translate to calibrated radiocarbon years of 675 and 740 BP, also consistent with an assignment to the Middle-Late Period transition, but not the earlier time segment.

Haliotis Beads and Ornaments

Approximately 35 *Haliotis* shell ornaments and 14 *Haliotis* shell beads were recovered during excavations at SFR-4/H (Table 10). The *Haliotis* bead types were classified according to Bennyhoff and Fredrickson's 1967 typology. The *Haliotis* ornament types are reported here according to Bennyhoff's ornament typology, partially outlined by Bennyhoff and Hughes (1987:144-146) and more fully documented by Bouey (1995). The ornaments are also categorized in accordance with an alternative typology developed by Gifford (1947), who includes illustrations of each type. Bennyhoff and Hughes' Table 10 (1987:144) cross-references the Bennyhoff and Gifford *Haliotis* ornament type designations (see Appendix C for details).

The *Haliotis* shell artifacts include beads (n=14), circular disk ornaments (n=18), elongate pendant ornaments (n=11), and very large gorget ornaments (n=6).

Haliotis beads are distinguished from *Haliotis* ornaments by their small size (<20 millimeters maximum diameter) and their occasional appearance in relatively large lots (n>100). The 14 *Haliotis* beads recovered at SFR-4/H, all associated with Burial 7 (Table 10), are round (type H3a) and sub-rectangular (type H1) nacreous (epidermis-removed) beads. These types are often referenced as *Haliotis* "sequins" in the literature. The disk form dates to the Intermediate Middle Period, while the rectangle is usually associated with the Early Period.

Eleven *Haliotis* ornaments were found in association with Burial 34 (Table 10). All were disk form (type K6), each with two adjacent edge perforations; these date to the Early Period. Several *Haliotis* ornaments of broad ovate form with serrate edges and double edge-perforations were found in association with midden component Burial 28. These may be more highly elaborate variants of the round forms found with Burial 34. Similar disk ornaments were found in association with midden-base burials at the Emeryville Shellmound, ALA-309. It appears that this ornament type persisted for a long period in the Bay Region; it is diagnostic of the first half of the Middle Period as well as the Early Period. In the SFR-4/H shell midden stratum, *Haliotis* ornaments of teardrop form were found in association with a number of burials. This form appears to have persisted over a long period of time in the Bay Region but is very common in Middle Period burials.

The *Haliotis* pendants represent three specific forms, oblong (n=1), narrow triangulate (n=8) and narrow triangular (n=2). The narrow triangular and triangulate artifacts were recovered in association with Burial 6, while the oblong artifact was recovered, without associations, in the Unit 2 midden. Based on prior research elsewhere, all forms date to the Late Middle Period, with the double-perforated form extending into the Late Period (Table 10).

Table 10. *Haliotis* Ornaments and Beads.

Ornament Type (Bennyhoff and Hughes 1987)	Gifford Type	Temporal Significance	Catalogue Number	Number of Items	Provenience	Temporal Component
Haliotis Nacreous "Sequins"						
Nacreous disk - H3a		Intermediate Middle Period	0844	13	Burial 7	Middle Period
Nacreous rectangle - H1		usually Early Period	0844	1	Burial 7	Middle Period
Haliotis Disk Ornaments						
Lightly-incised Simple Disk - rCA3a	K2bII	Intermediate Middle Period	1486	1	Burial 28	Middle Period
			1487	1	Burial 28	Middle Period
			1488	1	Burial 28	Middle Period
Bar-Scored Simple Disk - uCA3h	K2bIII	Middle/Late Transition	0856	1	Burial 4	Middle/Late Transition
			0857	1	Burial 4	Middle/Late Transition
Undecorated, Double-perforated Disk - uCA5j	K6	Early Period	1489	1	Burial 34	Early Period
			1490	1	Burial 34	Early Period
			1491	1	Burial 34	Early Period
			1492	1	Burial 34	Early Period
			1493	1	Burial 34	Early Period
			1494	1	Burial 34	Early Period
			1495	1	Burial 34	Early Period
			1496	1	Burial 34	Early Period
			1497	1	Burial 34	Early Period
			1498	1	Burial 34	Early Period
			1499	1	Burial 34	Early Period
			1471	frags	Burial 34	Early Period
Narrow Ring - uC2C1j	J2aIV	Early/Middle Transition; Early Middle Period	0345	1	Unit 6, 50-60 cm	Mixed Late-Middle/Late Transition
Haliotis Pendant Ornaments						
Double-perforated Oblong Pendant - uBC4j	S8aIII	Late Middle Period, Late; Late Period 1A	0075	1	Unit 2, 120-130 cm	Early Period
Narrow Triangulate Pendant - uEB3j	U2aIII	Late Middle Period	0869, 0871-0874, 0876-0878	8	Burial 6	Middle Period
Narrow Triangular Pendant - uOB3j	QIaIII	Late Middle Period	0870, 0875	2	Burial 6	Middle Period
Haliotis Gorgets and Whole Shells						
Triangular Gorget - fOH3a	AF4b	Middle Period	0867, 0868	2	Burial 6	Middle Period
Triangulate Gorget - rE2F3f	AF5bi	Intermediate Middle Period	1483	1	Burial 28	Middle Period
			1484	1	Burial 28	Middle Period
			1485	1	Burial 28	Middle Period
End-Perforated Partial *Haliotis* Shell - SE5j	K6a	not diagnostic; but assoc w/Late Middle Period burial	0847	1	Burial 12	Middle/Late Transition
Clam Shell Disk	V1a	Late Period, Ph. 2	0271	1	Unit 28N/5W, 0-20 cm	Middle/Late Transition
Turban Shell Ring	Class J	not diagnostic	0444	1	Unit 11N/2.5E, 20-30 cm	Middle/Late Transition

Five gorgets and one perforated "near-whole" *Haliotis* shell were recovered at SFR-4/H; two were recovered with Burial 6, one with Burial 12, and three with Burial 28. Gorgets are classified by Bennyhoff (in Bouey 1995) as "large" variants of triangulate, triangular, and rectangular forms. The forms variously date to the Early Middle, Intermediate Middle, and Late Middle periods (see Table 10).

Projectile Points

Only two projectile points, both manufactured of obsidian, were recovered from the site. A nearly complete Stockton serrated point yielded a 1.5 micron hydration rim reading (Napa Valley), consistent with both its stratigraphic provenience near the surface of the shell midden and the Late Period placement of the type. The second projectile point, which may have been a fragment of a large contracting-stem point, suggests an Early or Middle Period placement typologically, and yielded a hydration rim of 2.5 microns (Bodie Hills). It was found at the surface of the site.

Charmstones

Three burial-associated perforated charmstones were recovered. One was lemon-like in form and two were asymmetrical spindles, each with a groove over the perforated end. One of the spindle charmstones was heat-fractured, probably as a result of grave-pit burning. Perforated charmstones are considered diagnostic of the Early Period in the Bay Area. The associated burials were directly dated to 3100 cal BP (Burial 33) and 3200 cal BP (Burial 34), consistent with an Early Period assignment. Charmstones of similar forms were recovered from the basal levels of ALA-309, with burials that may date as early as 2800 BP. Site ALA-307 (the West Berkeley shellmound), with a basal date of about 3500 BP, yielded similar perforated charmstones (Wallace and Lathrap 1975).

Unperforated charmstones were fairly common in the SFR-4/H shell midden but rarely in burial contexts. They tend to be less finished and heavily battered in form. These may be related, typologically, to the ground stone forms described as grooved or notched cobbles, which also are relatively abundant in the midden at the site. These cobbles at one time were considered to be an Early Period or Early and Middle Period diagnostic trait; however, they may have continued to be used into the Middle and Late periods at SFR-4/H, as has been suggested for a similar assemblage of similar date at SFR-112 on the San Francisco shore opposite Yerba Buena Island (Pastron and Walsh 1988a).

CHRONOSTRATIGRAPHY AND COMPONENT DEFINITION (by Jeffrey Rosenthal)

As noted earlier, three major strata were identified at SFR-4/H: Stratum I is historic-era fill; Stratum II is a loose, deep, black, shell midden; and Stratum III represents a basal cultural layer of dark, yellowish to light brown sand. Within shell midden Stratum II, three periods of occupation were identified: Middle, Middle-Late Transition, and Late. Stratum III, in the sub-midden sand, was primarily represented by Early Period burials and their associated artifacts.

Stratum II: Shell Midden

The shell midden of Stratum II, sampled in hand excavation units at SFR-4/H, is divided into three stratigraphic components (IIa, IIb, IIc), based primarily on the distribution of obsidian hydration readings and radiocarbon dates (Table 11). Due to a lack of chronological information, material recovered from four of the units (A, B, 35N/6E and 31N/13E) could not be assigned to a discrete temporal component.

The upper portion of the shell midden was identified as Stratum IIa and is associated with Phase 1 of the Late Period (700-400 cal BP) based on 29 Napa Valley hydration readings averaging 1.7µ (± 440 cal BP), and two radiocarbon dates of 590 and 595 cal BP (Table 12; see Figure 14). This deposit forms the surface stratum across most of the site and is thickest to the southeast, where it extends from the surface to as much as 90 centimeters deep (i.e., Unit 2).

Stratum IIb occupies an intermediate position in the midden and dates to the Middle-Late Period Transition (900 to 700 cal BP) based on five associated hydration readings averaging 2.4µ (± 885 cal BP) and three radiocarbon dates of 725, 730, and 745 cal BP (Table 12). A fourth intrusive date of 1245 cal BP is also associated with this stratum in Unit 11N/2.5E. Stratum IIb is found only in the southeastern portion of the site and is represented mainly in Units 11N/2.5E, 9N/3.5E, and 2.5N/2.5E (see Figure 14).

The lowest component recognized within the shell midden is Stratum IIc. This deposit dates to the Middle Period (2200 to 900 cal BP) based on nine hydration readings averaging 3.0µ (±1380 cal BP), and a single radiocarbon date of 1685 cal BP (Table 12). The Middle Period stratum is found across the entire site area and ranges in depth between 60 and 100 centimeters below surface in the southeastern units, and represents near-surface deposits in the northwestern units (e.g., Unit 4, 14.5N/2E, 28N/5W).

Table 11. Stratigraphic Components by Control Unit and Corresponding Chronometric Information.

Unit	Depth (cm)	Stratum	Obsidian Hydration	14C cal BP	Other
1	0-60	II a	(NV)1.5, 1.6, 2.2	-	Stockton Serrated Arrow
	60-90	III	-	-	
2	0-90	II a	(NV) 1.4, 1.4, 1.4, 1.5, 1.5, 1.5, 1.6, 1.6, 1.7, 1.9, 2.5; (AN) 1.7	-	
	90-140	III	-	-	*Haliotis* Type S8aIII
3	0-70	II a	(NV) 1.7, 1.9, 1.9/3.1; (BH) 2.5	-	
	70-100	II c	-	-	
	100-120	III	-	-	
4	0-140	II c	(NV) 1.8, 3.0, 3.4	1685	
6	0-100	II a/b	(NV) 1.6/3.2, 1.7, 2.1, 2.6	-	A1b *Olivella* bead; *Haliotis* Type uC2C1j
	100-130	II c	(NV) 3.3	-	
7	0-20	-	-	-	
8	0-60	II a	(NV) 1.7, 1.8, 1.9	-	
	60-80	II c	-	-	
	80-120	III	-	-	
2N/2.5W	0-20	II a	(NV) 1.5	-	
	20-120	II b	(NV) 2.4, 2.7	-	
	120-140	III	-	-	
9N/3.5E	0-40	II a	(NV) 1.3, 1.3, 1.6, 2.0	590, 595	
	40-100	II b	(NV) 2.4	725	
7N/13E	0-50	II a	(NV) 1.4, 1.5, 1.9	-	
	50-70	II b	-	-	
11N/2.5E	0-10	II a	(NV) 1.9		
	10-100	II b	-	730, 745, 1245	*Tegula* ring bead
14.5N/2E	0-80	II c	(NV) 4.2	-	
	70-80	III	-	-	
19N/4W	0-10	II a	(NV) 1.3	-	
	10-40	II c	(NV) 3.2	-	A1c *Olivella* bead
24N/3E	0-55	II a	(NV) 1.8	-	
28N/5W	0-20	II b	(NV) 2.2; (AN) 1.3	-	Clam disk bead
	20-90	II c	(NV) 1.9, 3.0, 3.3; (AN) 2.3	-	A1b *Olivella* bead
31N/13E	0-50	-	-	-	
35N/6E	0-60	-	-	-	M1a *Olivella* bead
A	0-50	-	-	-	
B	0-80	-	-	-	

Table 12. Summary of Chronological Information from Control Units by Stratum.

Stratum	Napa Valley				Annadel	14C cal BP	Period
	Readings (µ)	Mean	SD	CV	Readings (µ)		
II a	1.3, 1.3, 1.4, 1.4, 1.4, 1.4, 1.5, 1.5, 1.5, 1.5, 1.5, 1.5, 1.6, 1.6, 1.6, 1.6, 1.7, 1.7, 1.7, 1.8, 1.8, 1.9, 1.9, 1.9, 1.9, 1.9, 1.9(3.1), 2.0, 2.2, 2.5	1.7	0.27	0.16	1.7	595, 590	Late, Phase 1
II a/b	1.6(3.2), 1.7, 2.1, 2.6	2	0.45	0.23		-	Mixed, Middle and Late
II b	2.2, 2.4, 2.4, 2.7	2.4	0.28	0.09	1.3	725, 730, 745, 1245	Middle-Late Transition
II c	1.8, 1.9, 3.0, 3.0, 3.2, 3.3, 3.3, 3.4, 4.2	3	0.74	0.25	2.3	1685	Middle
Notes: µ – Microns, S.D. – Standard deviation; C.V. – Coefficient of variation; (3.2) – Second band, not used in statistical calculation.							

Associated Burials

Four burials (numbers 6, 7, 22, and 28) date to the Intermediate and Late Phases of the Middle Period, judging by radiocarbon assays, obsidian hydration information, and shell bead associations (Table 13). The Middle Period burials are located in the basal shell midden (Stratum IIc) or sub-midden pits within the southeastern portion of the site.

Two burials (4 and 12) situated in the shell midden on the northwestern side of the site are associated with the Middle-Late Period Transition, based on radiocarbon dates, obsidian hydration, and shell bead associations (Table 13). Lastly, one burial (Burial 2) is associated with Phase 1 of the Late Period based on its relatively high position in Stratum II (see Figure 14) and a radiocarbon date of 470 cal BP. Ten other burials could not clearly be assigned to any of the Middle or Late shell midden components (Table 13); however, of these, the depth of burials 8, 11, and 23 indicate that they should most likely be assigned to the Middle Period.

Table 13. Burials by Component, Stratum, and Associated Chronological Information.

Period	Stratum	Burial #	14C cal BP	Hydration: Napa (µ)	Diagnostic Artifacts
Late, Phase 1	II	2	470	-	-
Middle-Late Transition	II	4, 12	665, 845, 890	2.1, 2.2	*Olivella* M1a; F3a; *Haliotis* K2bIII; K6a
Middle, Late	II	6	1210, 1255, 1295	2.9, 3.0	*Olivella* F2c/d; F3a,b; *Haliotis* fOH3a; QIaIII;U2aIII; AF4b
Middle, Intermediate	II	7, 22, 28	1345, 1395, 1405, 1435, 1485, 1570	4.9	*Olivella* F2a,b,c/d; F3a; *Haliotis* H3a; H1; K2bII; AF5bi
Early	III	1, 3, 9, 10, 13, 17, 18, 20, 21, 27, 29, 30, 33, 34	3100, 3175, 3195 3255, 3275, 3390, 3400	3.2	Charmstones; *Haliotis* uCA5j
Unknown	II	5, 8, 11, 14, 15, 16, 19, 23, 24/25, 26	-	-	-

Stratum III: Sub-Midden

Although the sub-midden, Stratum III, at SFR-4/H was not widely or systematically sampled through hand excavation, basal levels of six units sampled the upper portion of this deposit (see Table 12). Unfortunately, no chronological information from these sub-midden levels was obtained. Shell and perhaps other organic material were present in this stratum and might be radiocarbon-dated in the future. Until then, we infer that Stratum III dates to the Early Period (i.e. >2500 cal BP) based on the oldest date from Stratum II (i.e., 1685 cal BP) and seven radiocarbon dates ranging between 3100 and 3400 cal BP from burials recovered in the sub-midden sand (Table 13).

Associated Burials

Approximately one-half (n=14) of the burials recovered from SFR-4/H are associated with the sub-midden sand (Stratum III). They are assigned to the Early Period (see Table 13) based on their stratigraphic position and associated radiocarbon dates ranging between 3100 and 3400 cal BP (see Figure 14). In addition, burials 15, 19, and 26 (all classified as undetermined in age) are most likely from the Early Period, judging by their depths (see Figure 14). All of these burials were encountered during mechanical grading following hand excavations and could not be directly linked to a specific stratum.

Summary of Temporal Components

Table 14 details the units/levels and burials associated with the four identified temporal components at SFR-4/H; they are graphically presented in Figure 14. The Late Period component was present in 11 excavation units across the site, with depths ranging between 0 and 90 centimeters; only one burial was dated to this period. Evidence for the Middle/Late Transition was found in five units, ranging from 0 to 120 centimeters below surface, with the inclusion of two burials. Seven units evidenced Middle Period occupation, from 0-130 centimeters, with four associated burials. Fourteen of the burials, along with the lowest depths of six

Table 14. Temporal Components by Burial, Feature, and Unit/Level.

	Late (IIa)	**Middle/Late Transition (Iib)**	**Middle (Iic)**	**Early (III)**	**Mixed or Undated Midden**
Associated Burial Number	2	4,12	6, 7, 22, 28	1, 3, 9, 10, 13, 17, 18, 20, 21, 27, 29, 30, 33, 34	5, 8, 11, 14, 15 , 16, 19 , 23 , 24/25, 26
Feature Designation	Unit 1, Feature 1	-	Unit 4 Feature 1; Unit 14.5N/2E, Feature 1	-	
Feature B					
Units					
1	0-60			60-90	
2	0-90			90-140	
3	0-70		70-100	100-120	
4			0-140		
6			100-130		0-100
7	0-20				
8	0-60		60-80	80-120	
2N/2.5W	0-20	20-120		120-140	
9N/3.5E	0-40	40-100			
7N/13E	0-50	50-70			
11N/2.5E	0-10	10-100			
14.5N/2E			0-70	70-80	
19N/4W	0-10		10-40		
24N/3E	0-50				
28N/5W		0-20	20-90		
31N/13E					0-50
35N/6E					0-60
A					0-40
B					0-70
Total Cubic Meters	6.46	5.2	6.0	1.9	4.65

units (only 1.9 cubic meters), dated to the Early Period. No chronological information was obtained from four units and ten burials, leaving them undated; however, based on depth alone, three burials (8, 11, and 23) are likely associated with the Middle Period, and three (15, 19, and 26) are likely associated with the Early Period.

In addition, one unit produced material that is considered temporally mixed (Unit 6, Iia/b), with four others containing no dated material (see Table 14), all within the upper 100 centimeters of the site. The material from these units will not be considered in the component analysis to follow.

HUMAN REMAINS

The burial population at SFR-4/H consisted of 31 individuals, all recovered during mechanical clearing of the ADI. Burials were interred at all levels within the shell midden and immediately below its base (Table 15; Figure 19).

Table 15. Burial Distribution by Stratigraphic Component.

Burial #	Discovery/Provenience	Sex	Age	Associations
Late Period				
2	Trench B, 67 cm below midden surface; within shell midden	Male	30-45	Unmodified Elk pelvis (?)
Middle/Late Transition				
4	Backhoe scraping; 8.06 ASL, within shell midden	Female	15-20	1,100 beads; 2 *Haliotis* ornaments, 1 flake ochre
12	Backhoe scraping; 8.49 ASL, base of midden, midden stained matrix	Male	20-30	*Haliotis* pendant, 8 *Olivella* beads, obsidian blades
Middle Period				
6	Backhoe scraping; 7.75 ASL, in shell midden	Female	25-35	459 *Olivella* beads, 12 *Haliotis* ornaments, steatite pipe bowl, ochre
7	Backhoe scraping; midden stained sand below shell midden	Male	20-30	Elk tibia wand, strigil, *Haliotis* sequins, 75+ *Olivella* beads
22	Backhoe scraping, 7.0 ASL, midden stained sand	Female	60+	75+ *Olivella* beads, 4 bone needles, 9 flakes
28	Backhoe scraping; 7.04 ASL, shell midden	Ind.	9-11	103 *Olivella* beads, 4 *Haliotis* ornaments, chert biface
Early Period				
1	Backhoe scraping, traces of midden in matrix	Female	Adolescent	None
3	Backhoe scraping, in sand below midden	Female ?	Adult	None (possibly 1 flake)
9	Backhoe scraping; in sand	Ind.	8-12	Oyster shells
10	Backhoe scraping; deep sub-midden sand	Female	25-35	1 mortar, one flake
13	Backhoe scraping; sub-midden	Female	40-50	1 flake
17	Backhoe scraping; 8.5 ASL, sub-midden	Female	20-30	Pecked stone, modified flake
18	Backhoe scraping; 8.68 ASL, sub-midden	Female	45-55	None
20	Backhoe scraping; 8.55 ASL, sub-midden	Female	45-55	2 chert flakes
21	Backhoe scraping; sub-midden	Female ?	20-30	None
27	Backhoe scraping; 6.52 ASL, sub-midden sand	Ind.	9-15	None
29	Backhoe scraping; sub-midden sand	Male	27-30	None
30	Backhoe scraping; sub-midden sand	Ind.	23+	None
33	Backhoe scraping; sub-midden sand	Male	20-24	Pointed bone tool, charmstone, flake
34	Backhoe scraping; sub-midden sand	Ind.	12-18	11 *Haliotis* ornaments, 2 charmstones, hair pin, 2 steatite ornaments, canine tooth

Table 15. Burial Distribution by Stratigraphic Component *continued*.

Burial #	Discovery/Provenience	Sex	Age	Associations
Mixed or Undated				
5	Backhoe scraping; midden stained sand, probably sub-midden	Female	35-50	1 flake, 1 core tool
8	Backhoe scraping; in shell midden	Ind.	Adult	None
11	Backhoe scraping; in shell midden	Ind.	Infant	Large clamshell
14	Backhoe scraping; midden stained stand	Ind.	4-8	None
15	Backhoe scraping; shell midden	Male?	30-40	Possible fish bead
16	Backhoe scraping; likely sub-midden, with midden-stained sand	Male	35-50	Steatite cylinder
19	Backhoe scraping; mixed midden and sand	Female	30-40	2 bone tools, notched cobble, one flake
23	Backhoe scraping; shell midden	Female	50-60	Mammal rib fragment
24/25	Backhoe scraping; shell midden	Ind.	9-10	Pecked cobble, 1 flake
26	Backhoe scraping; sub-midden with midden-stained sand	Ind.	25+	None
Notes: Numbers 31 and 32, first identified as reddish stains common to other burials, turned out to be neither burials nor cultural.				

Of the 21 individuals in the burial population for whom sex could be determined, 14 were identified as female or probably female, and seven were identified as male or probably male. Of the 10 individuals for whom sex could not be determined, seven were children (including one infant) or young adolescents, and the skeletons of three were too incomplete for sex determination.

The burials demonstrated a high occurrence of degenerative and trauma-related pathologies. In every individual older than adolescence, skeletal evidence for at least two different pathological conditions developed. This high occurrence of degenerative and trauma-related pathologies suggests a high degree of mechanical stress in the daily activities of these people. Pathologies affecting both the cranial and post-cranial skeleton include non-specific infectious diseases, degenerative joint disease of the axial and appendicular skeleton, hematological disorders, and perimortem trauma.

Twenty-seven individuals retained dentition that could be analyzed. Most of the individuals showed some degree of tooth wear; in mature adults it was extreme, with molars ground down to the gum line.

DNA analysis was undertaken on 20 of the burials, with the consent of the Native American Most Likely Descendant. Beyond a general population characterization as “Asian” or “Asian/American” haplotypes (gene segments), there is insufficient data to address any issues of population comparisons or movement. The study is detailed in Appendix N.

Of the 31 burials identified, 10 were not dated; the remainder were classified by component. The majority (n=14) were associated with the Early Period, along with four Middle Period burials, two Middle-Late Transition burials, and one Late Period burial.

For the dated burials, gender could be determined for 16 (76%); all but two were given age ranges; and the presence/absence of pathologies was identified on all but two. The single extended burial (#2) was associated with the Late Period, while flexion, presence of a pit, grave-pit burning, and orientation were variously present within time periods (see Table 15). Notably, Middle-Late Transition burials were flexed, while most Early Period burials were more tightly flexed. Beads and ornaments are well-represented in Middle Period and Middle-Late Transition burial contexts, while only one Early Period burial, a young individual of indeterminate gender, had any significant number of burial associations (16 items). A detailed discussion of field and lab methods and a detailed description of each burial are found in Appendix F, with associated beads and ornaments detailed in Appendix C.

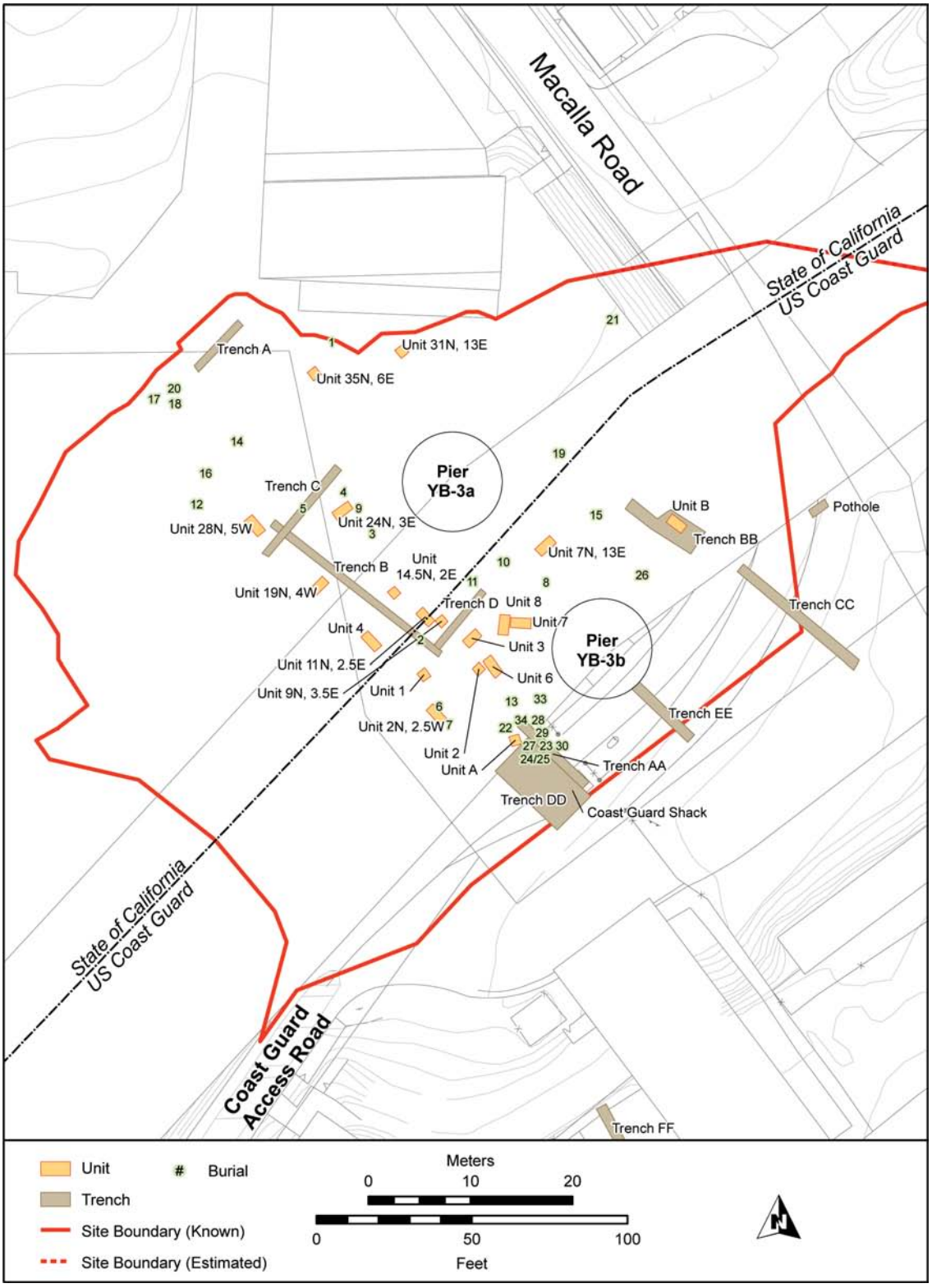


Figure 19. Burial Locations at SFR-4/H.

FEATURES

Four prehistoric features were identified during excavation, one cluster of bird bone associated with the Late Period, two rock/ash lenses associated with the Middle Period, and an undated pit feature.

Bird Bone Cluster (Trench B, 60-70 cm; Late Period)

This feature consisted of a concentration of golden eagle (*Aquila chrysaetos*) bones (Cat. #0658), which may represent an intentional animal burial. The feature is in close proximity to and on the same horizontal level as Burial 2, in the southern part of the excavated area. Burial 2 returned a radiocarbon date of 470 cal BP on charcoal (Beta 172582, Cat. SFR-4-1087). The eagle bone feature is represented by a left scapula, proximal right ulna, distal right carpometacarpus, the proximal end/shaft of a radius, two fragments of the acetabulum of the sacrum, left and right femur heads, a proximal fibula, proximal and distal right tarsometatarsii fragments, left and right first metatarsals, four whole phalanges, a distal phalanx, and 100 plus associated fragments.

Rock and Ash Feature (Unit 4, Feature 1, 20-30 cm; Middle Period Component)

This feature, possibly a fire hearth, consisted of rock and ash. It included six large cobbles, three of which formed a semicircle, within a matrix of fine, charcoal-rich, reddish black midden. The ash lens covered most of the east side of the unit, and measured 80 x 95 centimeters. Peripheral ash was black; the ash closest to the cobbles was gray; the ash lens had a greenish gray tinge. The feature was photographed and illustrated (Figure 20 and Figure 21). The radius of a common murre (a sea bird) and a femur of a California meadow mouse femur (SFR-4-0124) were found within the feature.

Ash and Rock Feature (Unit 14.5N/2E, Feature 1, 20 cm; Middle Period Component)

A layer/pavement of cobble-sized fire-cracked rock and a 40-x-60-centimeter concentration of ash were noted as a feature in this unit at 20 centimeters in depth. The feature was not photographed, but was sketched in the level record. No artifacts were found in association with this feature.

Pit Feature (2004 Feature B, base of midden to one meter below base; undated)

Feature B was located west of Footing YB-3b, near the juncture between the eastern margin of the excavation and the western edge of the footing excavation. The feature consisted of a pit about 60 centimeters in diameter, which extended about one meter below the base of the midden. The pit fill consisted of shell midden and midden stained sand. The pit fill was not sampled, as the feature was discovered during mechanical clearing of the site and was not recognized as a feature until it became evident in cross-section. At the base of the pit, a length of unidentified root-like material was exposed. The specimen had the size and shape of a large root or antler, round in cross section and about five centimeters in diameter, and slightly twisted. The material was whitish, chalky, porous, and appeared partly mineralized. This specimen was positioned vertically in the base of the pit. The item was at first believed to be an antler, but subsequent multiple discoveries of similar material suggested that these specimens might be roots or root casts (Appendix E). In the case of Feature B, the discovery pit may be a natural feature, such as a large animal burrow or tree trunk mold, or could represent a hole left by the removal of a tree or backfill of a piling hole or another artificial feature at the time of the Naval Parade Ground construction or the YB-3b excavation.

Several specimens of the root-like material were collected for microscopic analysis (SFR-4-1540 and -1563 and SFR-4-1538 and -1473). They were assessed by Virginia Popper at the UCLA Paleoethnobotany Laboratory. Dr. Popper's microscopic examination of the material revealed no evidence of plant root morphology, except for the presence of modern rootlets. No conclusive interpretation can be offered, but these likely are mineral concretions of some kind.

Figure 20. Photo of Unit 4, Feature 1, Ash Lens/Possible Hearth Feature.

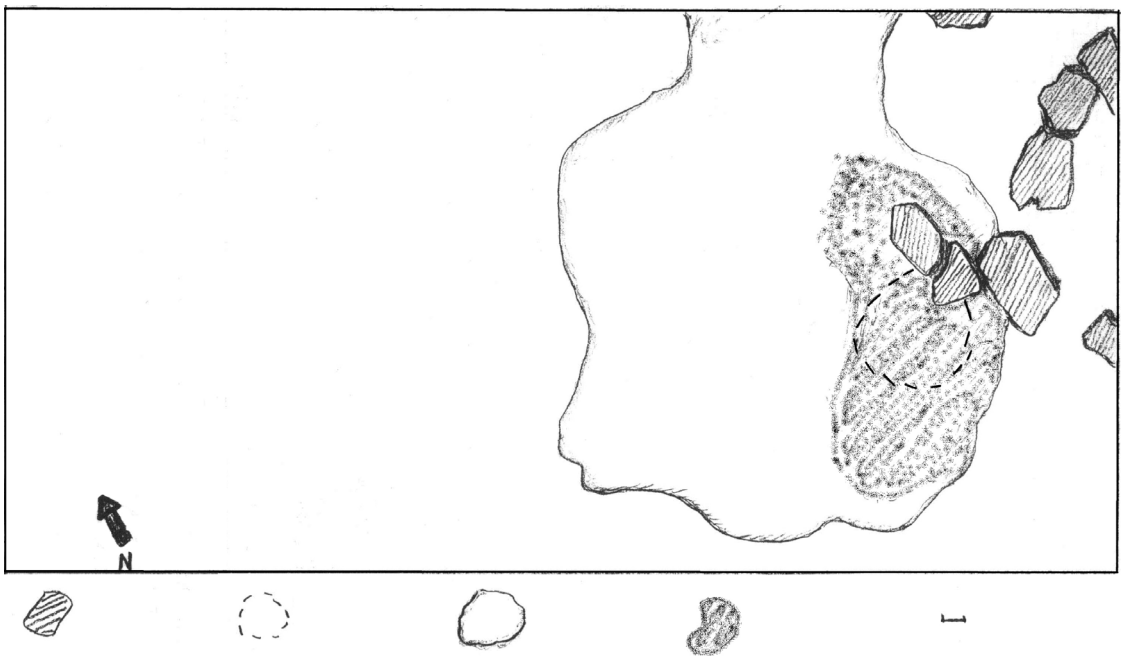


Figure 21. Illustration of Unit 4, Feature 1, Ash Lens/Possible Hearth Feature.

ARTIFACTS AND ECOFACTS

Excavations at SFR-4/H resulted in the recovery of 2,151 prehistoric artifacts, including flaked stone tools and debitage, ground stone, polished stone, shell beads (the majority found in association with six burials), *Haliotis* shell ornaments (also from grave lots), and modified bone (Table 16). Fish and mammal bone were abundant, along with sampled shell. Exotic materials represented in the assemblage include *Haliotis*, *Olivella*, and obsidian, artiodactyl bone, and probably steatite and serpentine schist. Of the artifacts, 92% could be associated with identified temporal components, along with 87% of the bone.

Debitage dominates unit assemblages, while *Olivella* beads predominate in the burials. Formed artifacts are sparsely represented throughout, with bifaces and cores being the most abundant flaked stone (n=22 and 11, respectively), followed by pointed bone (n=16); counts for all other artifact forms, by component, are less than ten, the majority with four or fewer (Table 16). Late Period Stratum IIa has the largest flaked and ground stone assemblage (n=133) but lacks beads; while beads dominate the Middle/Late Transition Period assemblage, primarily from one burial. Early Period Stratum III is primarily defined by burials with few associated items, with most artifacts coming from the deep levels of excavated units.

Bone counts were relatively high, but 32% could not be identified to species; fish bone was dominant in all components. Identified shell from temporal components totaled 28.5 kilograms, Relatively low densities of carbonized plant remains were encountered.

Summary descriptions of artifacts and faunal and floral remains are presented below, with a general discussion of each artifact type along with any relevant component-based information. Detailed descriptions of each resource can be found in Appendices A (flaked stone), B (ground and pitted stone), C (shell beads and ornaments), D (bone implements), E (faunal and floral remains), and F (human remains). A revised, simplified version of the catalogue is in Appendix H, and unit summaries (artifacts by level) are in Appendix I. All analytic data and the original catalogue are presented on disc as Appendices L-V.

Table 16. Assemblage by Temporal Component.

Artifact Type	Late Period (II a)	Middle/Late Transition (II b)	Middle Period (II c)	Early Period (III)	Mixed/ Undated	Totals
Flaked Stone						
Projectile Point	2	-	-	-	-	2
Biface	8	4	7	-	6	25
Drill	-	-	-	1	1	2
Core	4	3	4	-	1	12
Core Tool	1	-	4	-	1	6
Edge modified flake	2	1	6	1	-	10
Debitage	112	46	81	35	96	370
Ground Stone						
Mortar	1	-	-	1	8	10
Pestle	1	-	1	-	7	9
Miscellaneous groundstone	-	2	-	-	4	6
Grooved Stone	2	-	-	-	8	10
Notched Stone	-	1	1	-	5	7
Pitted Stone	-	3	-	1	-	4
Polished Stone						
Charmstone	3	3	-	3	7	16
Steatite ornament	-	-	-	2	-	2
Steatite pipe	-	-	1	-	-	1

Table 16. Assemblage by Temporal Component *continued*.

Artifact Type	Late Period (II a)	Middle/Late Transition (II b)	Middle Period (II c)	Early Period (III)	Mixed/ Undated	Totals
Modified steatite	-	1	-	-	1	2
Modified sandstone	-	-	-	-	3	3
Modified Bone						
Needle	-	-	4	-	-	4
Bi-Pointed Tool	-	-	-	3	-	3
Pointed Tool	5	1	4	3	8	21
Bead	1	-	-	-	1	2
Miscellaneous	-	-	1	-	2	3
Modified Shell						
Olivella bead	-	1,109	473	-	2	1,584
Haliotis disk	-	-	-	10	-	10
Haliotis ornament	-	-	2	-	-	2
Haliotis pendant	-	3	16	4	1	24
Tegula bead	-	1	-	-	-	1
Artifact Totals	142	1,178	605	64	162	2,151
Features	1	-	2	-	1	4
Human Interments	1	2	4	14	10	31

Flaked Stone Tools and Debitage

Projectile Points

Excavations at SFR-4/H yielded two projectile points and a few late-stage bifaces that likely are point fragments. One of the points is a Stockton Serrated arrow-sized specimen (Cat. 11) from the 10-20-centimeter level in Unit 1 (Figure 22). The stem and base have been broken, leaving no representative notch-type attributes. Remnant blank morphology shows this point was fashioned from the termination end of a long thin flake. Fine pressure flake scars are extensive on the dorsal face, and there are three distinct blade notches along each margin. Tip and neck breaks indicate probable impact damage. The arrow point is made of Napa obsidian and returned a hydration reading of 1.5 microns, consistent with a Late Period arrow form.

Figure 22. Stockton Series Point (-11).

The other specimen is a robust, dart-sized Contracting-stemmed point (Cat. 98) from the surface of Unit 3, made of Bodie Hills glass (2.5 microns). It has a relatively thick lenticular cross-section. Flake scar patterning shows pressure shaping over percussion scars. Ground facets along the stem edge indicate preparation for hafting or haft wear. An irregular outline and flake scar pattern along the blade margins indicate blade maintenance and reworking. Probable projectile point use wear is evident as nibbling edge damage, in addition to the broken tip. This projectile point appears well used. Edge nibbling along with less frequent stepping and crushing suggests that it was hafted as a cutting tool, or possibly a thrusting spear.

Both points were found within the Late Period component; however, as noted in the chronology section above, only the Stockton point is considered a Late Period form.

Bifaces

The collection also includes 24 obsidian bifaces and one made of chert (the latter associated with the Middle Period). Whole and nearly complete bifaces (28% of the biface assemblage) and fragments (72%) reflect a diversity of tool forms and uses. For the 22 specimens where stage could be determined, the majority are Stage-5 forms (76%) and the rest are Stage 4 (24%). Despite these late stages, most do not appear to have been projectile points.

Two outstanding bifaces in the collection were found with Middle/Late Transition Burial 12 (Figure 23). Both are made of Napa obsidian, and both are impressively large. Cat. 845, though missing its base, still measures more than 122 millimeters long. It was percussion shaped and pressure finished to a sharp slightly serrated edge. The asymmetrical tip appears to have been broken and repaired. Cat, 846 is whole and measures 92 millimeters in length. It has a long convex blade and a short pointed base contracting from slightly angled shoulders. This artifact was percussion-shaped and pressure-finished. Grinding on non-serrate basal edges probably facilitated hafting. Very slight serrations along the blade result from a final pressure flaking event and may reflect maintenance. Similar large, slightly shouldered bifacial artifacts were found at the Emeryville Shellmound (Schenck 1926: Plate 48). The interment of these two bifaces with a human burial reflects their importance as grave paraphernalia during the Middle/Late Transition.

Figure 23. Obsidian Bifaces (-845 and -846).

Drills

Two flaked stone drills, one chert and one obsidian, were recovered from SFR-4/H. The chert specimen (Cat. 548) is a relatively large, nearly complete tool from 80-90 cmbs in Unit 8 (Early Period). Its bit was bifacially pressure-flaked to form a durable diamond-shaped cross-section, constricted at its neck from pronounced shoulders. A bending break at the tip with a lateral finial extension indicates that the tip was broken in use. The base is relatively tabular, with bifacial margins and minimal thinning.

The other drill is a smaller, nearly complete obsidian tool with a pressure-flaked triangular bit tapering from slight convex shoulders (Cat. 628). The base is missing, but the remnant stem is bifacial and contracting. The well-shaped, narrow contracting stem indicates this drill was probably hafted. The specimen was recovered during mechanical excavations, from the upper 60 centimeters of the midden, and has an unknown temporal association.

Core Tools and Cores

Six core tools were recovered from SFR-4/H, five chert and one quartz (Figure 24). Two of the chert core tools are whole, angular chunks with no modifications other than use-wear in the form of crushing and rounding on the central projecting ridges and in one case a large spall off the ridge resulting from heavy percussion. A third whole chert core tool is a relatively small but robust percussion-shaped form made on a

cortical blank, found in association with Burial 5 (undated). The other core tools in the collection include a margin fragment of an angular chunk with step flaking and crushing on its one remnant edge; an end fragment of a split cobble with possible bifacial percussion edge-modification, and with stepping and crushing covering one projecting end; and a milky quartz cobble end fragment with some percussion modification, but of indeterminate form.

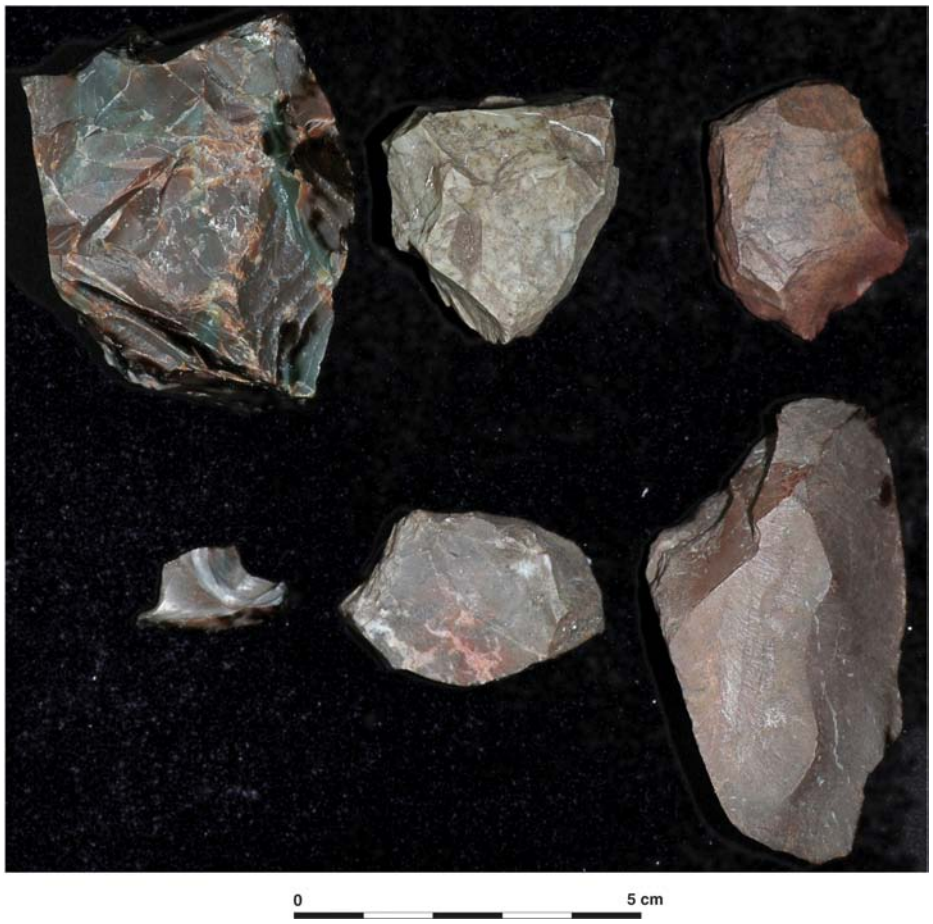


Figure 24. Selected Cores.

The cores include 10 made of chert and two of obsidian. The chert cores include four whole artifacts, one nearly complete core, four end fragments, and one margin. All are percussion flaked. Cobbles were typically selected for reduction, although the majority has been extensively flaked beyond blank recognition. Six show multi-directional flake removals

The two obsidian cores are bi-polar forms. Both are bifacially pressure-flaked and appear to have been shaped specifically for bi-polar reduction. The thin, wide, almost tabular bifacial form of these cores is unlike any of the bifacial tools in the SFR-4/H collection. These bifacial bi-polar cores most likely represent intentional bifacial core preparation for bi-polar reduction and controlled flake blank manufacture rather than the recycling of broken bifacial tool fragments. Similar obsidian bi-polar core reduction technology was discovered during recent investigations at the Emeryville Shellmound (Morgan n.d.).

While cores were fairly evenly divided across temporal components, obsidian cores only occurred in the Late Period. Four of the six core tools, all of chert, were associated with the Middle Period.

Edge-Modified Flakes

There are three obsidian and seven chert edge-modified flakes in the collection; these include only simple flake tools. The most interesting of these is a whole obsidian tool (Cat. 82) found in association with Middle Period Burial 6. It has three use edges with unifacial micro-flaking along straight and convex margins. The flake blank selected for tool use is a thin, flat, bi-polar flake removed from the face of a pressure-thinned biface.

A nearly complete obsidian flake tool (Cat. 861) was recovered with Early Period Burial 17. This tool was shaped from a cortical flake with intentional unifacial pressure modification of two irregular edges, creating a projection. There is no obvious use-wear along the edges or at the tip of the projection. This was the only piece of obsidian recovered from the Early Period sub-midden stratum of the site; it returned a hydration reading of 3.2 microns (Napa).

The third obsidian flake tool is the proximal fragment of a small, simple interior flake with two irregular unifacial micro-flaked edges, found in a Middle Period context.

The chert flake tools include three whole tools, one end fragment, and three margin fragments. They exhibit micro-flaking and crushing along their use-edges.

Debitage

Flaking debris is not abundant at the site, with only 370 pieces recovered, 96 (26%) of which were unprovenienced. Samples across the components range from 35 to 112, all very low counts. Obsidian debitage is clearly dominant in the Late Period (79%), and absent in the Early Period Component.

Obsidian

The obsidian debitage proportions show that cores, flake blanks, and late-stage bifaces were the predominant forms of imported obsidian. The minimal presence of obsidian cores in the flaked stone assemblage suggests that imported cores were completely reduced for tool manufacture. The discontinuity from minimal early biface reduction to a greater frequency of late biface reduction indicates that very few obsidian flake blanks were taken through the early stages of percussion biface reduction to make bifacial tools. Instead, most obsidian flake blanks probably went to make flake tools or pressure bifaces with no percussion flaking. Late stage bifaces were imported for bifacial tools. The pressure debitage reflects flake tool manufacture, pressure biface manufacture, and biface finishing, as well as tool maintenance. Despite the presence of bipolar obsidian cores at the site, there are very few bipolar flakes among the debitage.

Chert

The chert debitage is slightly more abundant than obsidian. Nearly 98% of the diagnostic chert flakes represent core reduction and initial flake-blank reduction. Cortical flakes account for more than 16% of the diagnostic sample, simple interior flakes made up nearly 77%, and complex interior flakes are about 4%. The low frequency of edge preparation flakes and near-absence of early and late biface thinning flakes and pressure flakes reflect a lack of chert biface manufacture that mirrors the paucity of chert bifacial tools in the flaked stone assemblage across time.

Summary of Flaked Stone Assemblage

Technological analysis indicates that exotic obsidian was brought to the site primarily as minimally worked cores, flake blanks, and late-stage bifaces and was used to make a variety of tools. Cores were turned into flake blanks, which in turn were used as flake tools. Late-stage bifaces include unfinished forms ready for finial shaping and use, and functional tool forms.

Chert, probably obtained on the island, was used at SFR-4/H for the manufacture of heavy-duty core tools and as cores to make blanks for flake tool manufacture. The large number of chert cores and the primary use of chert for expedient flake tools probably reflect the local availability of this toolstone. It was rarely used for biface manufacture; only two chert bifacial tools were recovered, one late-stage biface and one drill.

Of the component-associated material, chert is the exclusive flaked stone material used in the Early Period, and is dominant through the Middle-Late Transition. In the Late Period, however, obsidian becomes the prevailing toolstone, essentially reversing the prior ratios (Table 17). Both projectile points are obsidian, and bifaces are almost exclusively obsidian; chert dominants all other flaked stone tool classes, including debitage.

Table 17. Percentage of Material Type by Temporal Component.

	Late Period	Middle/Late Transition	Middle Period	Early Period
Chert	22.6	75.6	74.7	100.0
Obsidian	77.4	24.4	25.3	0.0
Counts	112	46	81	35

Ground/Modified Stone

This category takes in mortars and mortar fragments; whole and broken pestles; pitted, grooved, or notched stones; and miscellaneous unidentified ground stone fragments. These items are made almost exclusively of sandstone, varying from fine-grained to coarse-grained. For detailed descriptions and metrical data, see Appendix B. Unfortunately, most of these items were recovered from mixed or undated contexts, leaving only 30% (n=14) within dated components, and most of these are modified cobbles or miscellaneous ground stone.

Mortars

The ground stone collection from SFR-4/H includes one complete bowl mortar, one nearly complete bowl mortar, and seven mortar fragments. The nearly complete specimen (Cat. 853) was found with Early Period Burial 10, in the sub-midden stratum. This specimen is smaller than average (135 x 102 x 24.5 millimeters), probably too small for acorn grinding. The single complete mortar in the assemblage, Cat. 823 (an un-provenienced surface collection; Figure 25), is even smaller (73.8 millimeters diameter, 45.3 millimeters deep), of a size sometimes described as "miniature." Of the seven remaining specimens, one is a flat, fist-sized cobble with a deep pit in one face, and could only loosely be described as a mortar. Another has a relatively small basin. The remaining four specimens are base or wall fragments of larger mortars. All of the mortar specimens are manufactured from locally available sandstone. All but Cat. 853 were recovered from the shell midden component of the site, with one rim fragment (Cat. 176) associated with the Late Period and all others within mixed or undated components.

Figure 25. Miniature Bowl Mortar (-823).

Pestles

There are nine pestles in the SFR-4/H assemblage, only two of which were in dated contexts (one Late Period, one Middle Period); both are unshaped beach cobbles. Five were complete or nearly complete and four fragments. Three of the fragments show evidence of fire damage. In form, the pestles ranged from an unshaped, sub-cylindrical beach cobble to a finely finished, symmetrical cylinder (unprovenienced; Figure 26). Seven of the nine specimens are elongated cylinders with flattened cross-sections; one tapers markedly at one end. All of the specimens were manufactured of local sandstone of various textures.

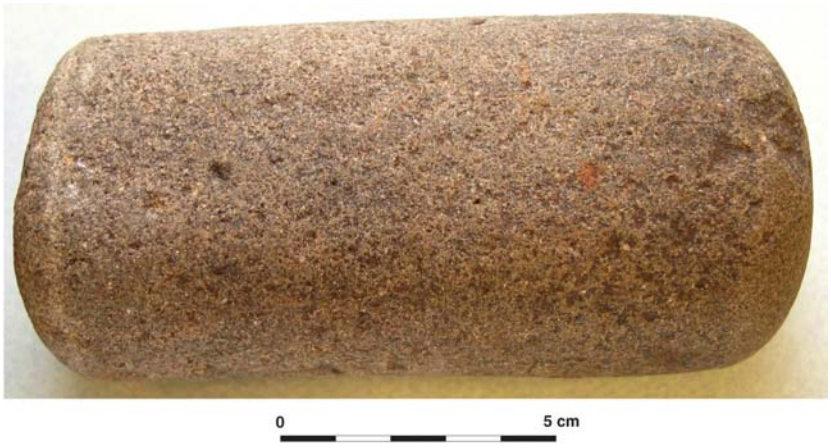


Figure 26. Pestle (-817).

Three of the unprovenienced specimens exhibit secondary use wear in the form of pecked and/or ground depressions on one or more faces. Bickel (1981:271) reported similar secondary use for six of the pestles recovered from the Patterson Mound (ALA-328) and attributed this to secondary use as anvils. In his 1907 report of excavations at the Emeryville Shellmound (ALA-309), Uhle recorded a "bipitted hammerstone" and a pestle shaft with pitting (Uhle 1907:49-50). Greenwood (1972) also reported pestles that had been used secondarily as anvil stones from the collection at Diablo Canyon (SLO-02). One fragment is ground flat on two opposing faces of the shaft, which suggests use in lateral grinding as well as pounding.

Pitted Stones

The four pitted stones from SFR-4/H (three from the Middle/Late Transition and one from the Early Period component) include two general forms of beach cobbles: slightly flattened, fist-sized or larger ovate shapes; and elongated, semi-cylindrical shapes. Each has an area of concentrated pecking or battering, roughly central to one or more faces. Scattered areas of additional pecking are also visible on some. The type is most frequently described in the literature as pitted stones (Breschini and Haversat 1992:79; Gerow and Force 1968:74; Fitzgerald 1993:64; Jones and Haney 1997:102; Rackerby 1967:56), but also as anvil stones (Adams 1996:13; Barrett 1952:60; Bickel 1981:271; Pastron and Walsh 1988a:55; Spier 1978:473; Haury 1976:278; Wallace and Lathrap 1975:26), or pitted hammerstones (Beardsley 1954a:10, 94; Fredrickson 1968:90). Beardsley included pitted stones as pestles in his typology. The early literature often described these items as "bi-pitted stones," "abalone pounders," or "nutcrackers." Interpretations of pitted stone use include acorn processing, shellfish cracking or pounding, and lithic core reduction.

The functional area of the artifacts appears to be the pitted surface, as none of the identified specimens exhibited evidence of pounding, grinding, or battering on other surfaces. This suggests that tools of this class either functioned as anvils or were used for downward pounding against a projection, perhaps in lithic core reduction.

Grooved or Notched Stones

Excavations at SFR-4/H produced 17 grooved and notched stones. These items, often termed "net weights" or "net sinkers," are well represented in many other Bay Region archaeological assemblages, as well, including the Stege (CCO-300), West Berkeley (ALA-307; Wallace and Lathrap 1975), and Ellis Landing (CCO-295) shellmounds in the East Bay (Nelson 1910; Wallace and Lathrap 1975); and University Village (SMA-77) in the West Bay (Gerow and Force 1968). They were the most numerous objects recovered from the West Berkeley shellmound, around 360 specimens (Wallace and Lathrap 1975:21). The larger Stege mound produced nearly 600 of these intriguing artifacts, an unusually large number (only two examples were recovered during excavations at the nearby Emeryville Shellmound [Morgan n.d.]).

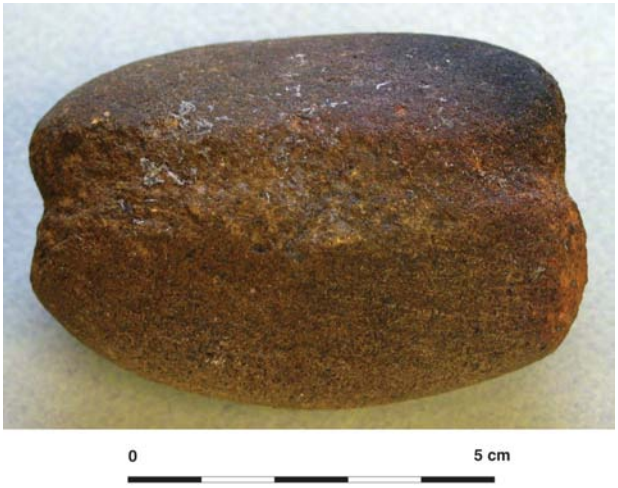


Figure 27. Grooved Stone (-61).

Grooved and notched stones are generally considered to have been weights on fishing or birding nets (Gerow and Force 1968:70; Pastron and Walsh 1988b:62; Wallace and Lathrap 1975:21). Wallace and Lathrap noted the co-occurrence of these artifacts with the greatest abundance of sturgeon bones in the assemblage and inferred that grooved and notched stones were net sinkers.

The SFR-4/H assemblage can be sorted into two somewhat distinct classes. Notched stones are generally somewhat flattened, fist-sized or larger oval cobbles with shallow notches usually placed at the midpoint of each of the two long opposing edges, as for attaching around the short axis of the cobble. Grooved stones, in contrast, are typically formed on cobbles about the size and shape of a goose egg but have slightly flattened cross-sections. They are encircled by pecked or ground grooves usually placed along the longitudinal midline, as for attachment around the long axis of the specimen (Figure 27). In the SFR-4/H assemblage, grooved cobbles tend to be made of coarse sandstone, while notched cobbles often are made of fine-grained or indurate sandstone. However, there is some overlap between the two subtypes in placement and degree of elaboration of the groove or notches. This overlap in axis placement and in groove/notch morphology suggests that the two types had shared functions.

This collection shows a great deal of variability within each type. Some of the "grooved" specimens are only lightly or partially grooved, with little more than an extended notch at each end, while others have a deep groove that encircles the entire specimen. One anomalous specimen is a large, flat, oval cobble with a groove along its short axis (Figure 28). Several specimens evidence additional forming of the cobble by scraping or pecking on faces or edges adjacent to the groove. One more finely worked specimen resembled a phallic charmstone in form. Notched cobbles also show considerable variability but in general are less formal in their manufacture. The notches are symmetrically placed but often irregular in depth and size. This suggests expedient manufacture. One of the notched stones (Cat. 459) is significantly larger and heavier that the rest; Wallace and Lathrap suggest, of a similar specimen at West Berkeley, that it served as a boat anchor.

Beardsley (1954a, 1954b) and Elsasser and Rhode (1996) classified several longitudinally grooved stones as types of charmstones. Some of these resemble the specimens recovered at SFR-4/H (e.g., Elsasser and Rhode 1996:103 [c,d,e]). The type usually refers to specimens that presumably had many uses, including atlatl or net weights, bola stones, or arrow shaft straighteners. Some were found with a single bi-conical perforation near one end, which further suggests the versatility of the type (Elsasser and Rhode 1996:101). Similar Roman-era specimens in the British Museum are classified as weaving shuttles (personal observation), and some forms might effectively have served as gauges in net manufacture.

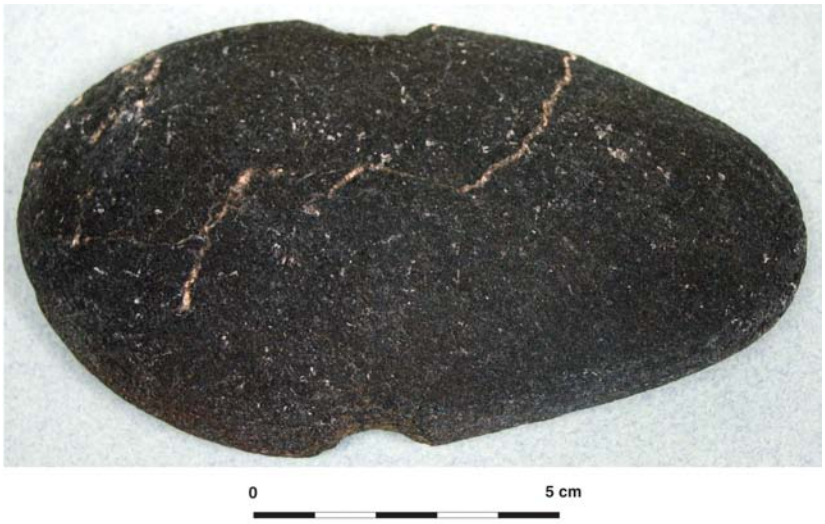


Figure 28. Grooved Stone (-357).

Most of these tools were recovered from non-provenienced areas (n=13); however, two grooved stones were within the Late Period component, one from the Middle/Late Transition, and one from the Middle Period component.

Miscellaneous Ground Stone

Six pieces of ground stone in the collection from SFR-4/H do not readily fit any of the functional types described above, and are classified as "miscellaneous," although each shares some attributes of a defined type. All six specimens are approximately fist-sized sandstone cobbles (three complete, three fragmentary) with concentrated areas of pecking or battering. All are informal in style and expedient in design. Four specimens show extensive battering on one or more curved shoulders, suggesting percussive use. All of the specimens are shorter in length and lighter in weight than artifacts classified as pestles. Only two of these tools could be placed within a dated stratum, both within the Middle/Late Transition.

Polished Stone Artifacts

This category includes charmstones/plummet stones, a pipe bowl made of black steatite, and several other steatite objects. These unique categories are discussed here in some detail; for complete descriptions and a discussion of individual artifacts, see Appendix B.

Charmstones

Sixteen items are classified as charmstones and three as possible charmstones (modified stone). Charmstones as a class include a wide variety of stone objects that are linked by a few key formal traits. The class, also referenced as "plummets," represents a variety of functions (Figure 29): the term charmstone, as used here, is not intended to imply a ritual or ideological function, but is used because it is the most common reference for this class of artifacts in Bay Region reports (Figure 30). These forms occur equally across the Late, Middle/Late Transition, and Early periods, but in low frequencies; none are documented in the Middle Period.

All of the charmstones from SFR-4/H are perforated forms. There is substantial variety in form and degree of workmanship, ranging from relatively graceful, elongated forms to squat, robust forms similar to Elsasser and Rhode's (1996) Type O (Oval). All share the characteristic pecking to form shoulders and a narrowed neck or tip; several have been pecked/shaped over their entire surfaces. The largest specimen, a cylindrical cobble, has a slightly curved body and a well-defined nipple at one end, and is slightly phallic in appearance.

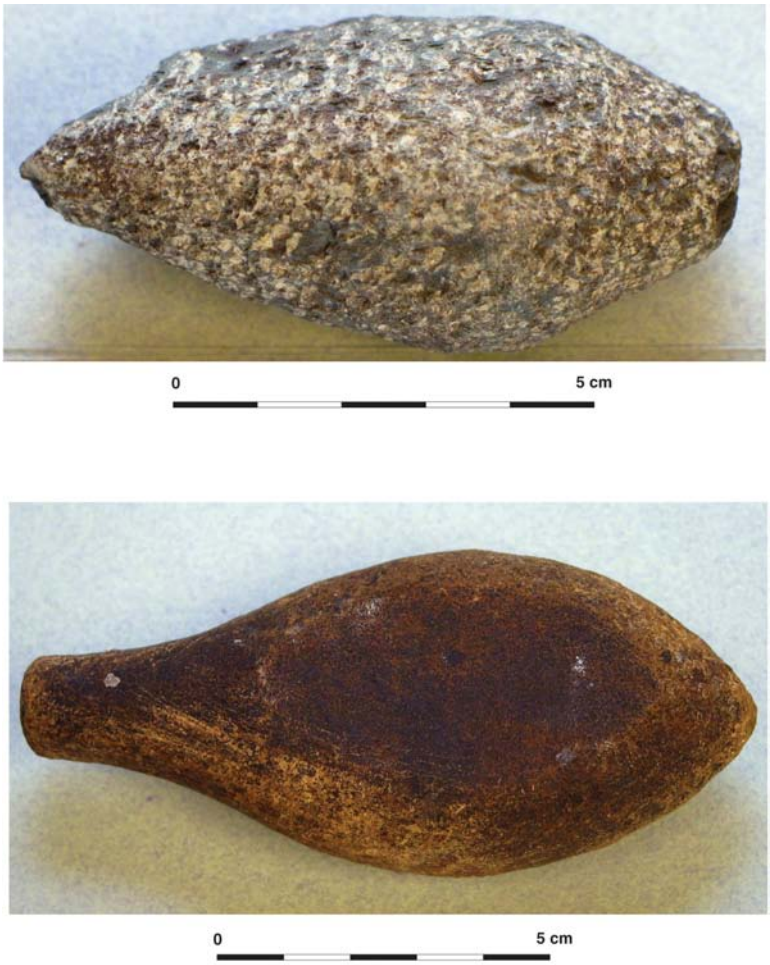


Figure 29. Plummet (-226) and Plied Plummet (-615).

Specimens from the midden component tend to be crudely formed, informal, and without finished detail. The majority of these specimens show little or no evidence of deliberate modification other than the concentrated pecking that forms shoulders and neck. Many are heavily battered and broken, lacking at least one tip. In contrast, the three charmstones recovered from below the midden (all recovered in association with burials) are finely shaped and polished, and all are of the perforated and grooved types that are considered to be time markers of the Early Period in central California (Berkeley Pattern on the Bay).

Charmstones have widespread distribution in archaeological assemblages throughout North America (e.g., Elsasser and Rhode 1996). Charmstones are believed to have bee used for both ceremonial and utilitarian purposes. Ethnographic accounts of ceremonial charmstone use (Grant 1978:514; Wallace 1978:457; Bean and Vane 1978:669) suggest that they functioned in hunting magic, by being attached to nets or other hunting equipment to attract game and improve the luck of the hunter. They are often found in graves. The simple charmstone forms typically associated with Late Period Bay Area sites (Beardsley 1954b:49; Pastron and Walsh 1988b:69) tend to be less elaborate and varied than the Windmiller types of the Early Period in the Sacramento Delta. The latter are almost always burial-associated, while the former are found in a variety of contexts.

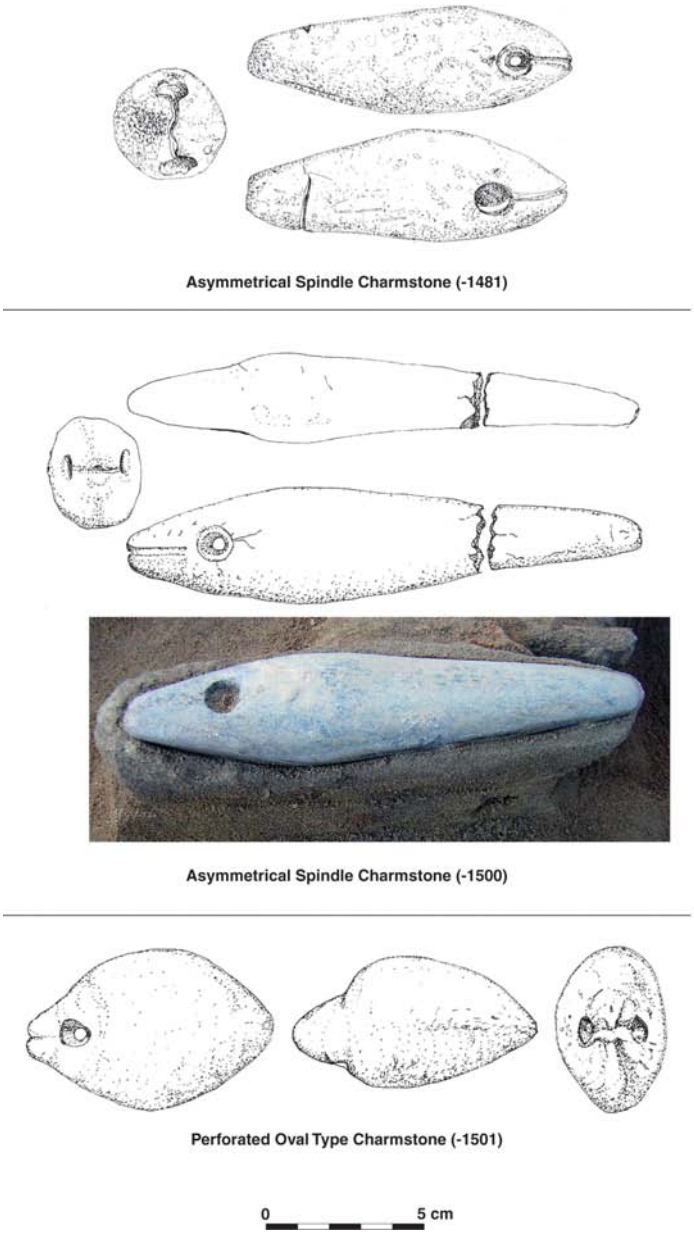


Figure 30. Asymmetrical Spindle Charmstones (-1481, -1500, and-1501).

Steatite Pipe Bowl

This item, made from black steatite, appeared to be a pipe bowl (Figure 31). It was found in association with Middle Period Burial 6 and has since been reinterred. The bowl, a tapering cylinder, measured 25.5 millimeters high, 22.5 millimeters at its widest diameter near the mouth of the bowl, and 15 millimeters at its narrowest diameter at the base of the bowl. The interior of the cylinder had been bi-conically drilled, with a wide conical bore forming the interior of the bowl and a second, smaller conical bore piercing the bowl from its base to form the perforation, presumably for the pipe stem. The interior of the bowl tapered sharply inward toward the base, with the interior measuring 17.8 millimeters wide at the mouth and 5.1 millimeters at the basal perforation. Both the interior and the exterior retained manufacturing striations, although both surfaces

had been polished. Drilling striations ringed the interior surface of the bowl and were clearly visible in the basal perforation. Striations on the exterior of the bowl were primarily vertical. Both the lip and the base of the bowl were smoothly beveled. The steatite used for manufacture apparently had some mineral inclusions, which were evident as imperfections in the exterior finish of the bowl. There was no evidence of adhesive or any means of attachment of a pipe stem.

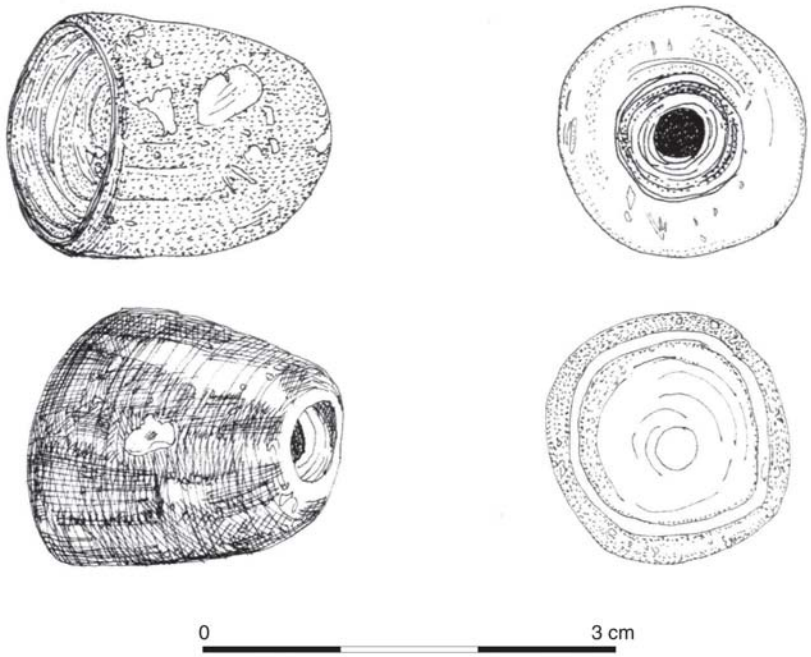


Figure 31. Black Steatite Pipe Bowl (-879).

Other Steatite Artifacts

Five other steatite objects were recovered from SFR-4/H, two ornaments and three pieces classified as "modified stone." These are presumed to be valued objects, judging by the use of exotic material and the degree of care shown in their manufacture. The two ornaments (described below under *Beads and Ornaments*) were found in association with Early Period Burial 34 and are scheduled for re-interment; the others had more scattered proveniences.

Rings

Two fragments of black steatite were recovered from the 50-60-centimeter level of Unit 6 (undated). They appear to be portions of two separate stone "rings" (Figure 32). Both are wider than they are thick, and both have flat cross-sections. These fragments, although smaller in projected diameter, may be consistent with the steatite rings reported by Wallace and Lathrap at West Berkeley (ALA-307), which, at 31 millimeters diameter, were "too small for a bracelet and too large for a finger ring" (Wallace and Lathrap 1975:23). Ring-shaped ornaments are common in Delta region Middle horizon sites, according to Wallace and Lathrap (1975:23). Bennyhoff termed these 'thin ring beads' (1994a:68, Figure 45) and attributed them to the Late Horizon. These artifacts were recovered from the same unit as the majority of the grooved or notched stones with clear provenience. It is possible that the rings are fragments of fishhooks or other fishing paraphernalia.

Cylinder

Catalogue #848 (Figure 33) is a small cylinder of black steatite found in association with undated Burial 16. The ends of the cylinder are flat and have been ground smooth, though there are several remnant striations across the ends. One end shows evidence of residue of some kind, perhaps asphaltum or another adhesive. The faces of the cylinder are rounded and fairly rough, with grinding striations clearly visible on the surface. This item is interpreted as a large labret (lip plug) or ear spool. There are archaeological examples of similar ornaments with applied shell bead decoration, and it is possible that the adhesive on this example is a remnant from decoration of this kind. This specimen was re-interred with Burial 16.

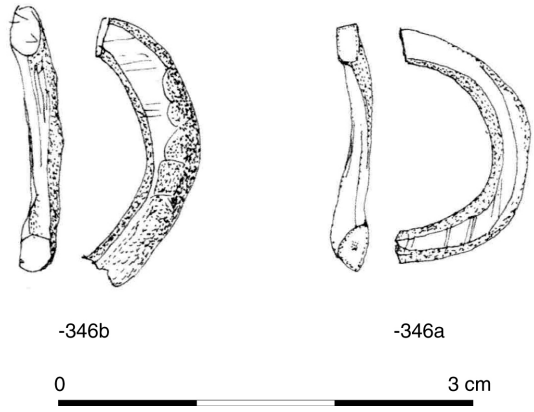


Figure 32. Postulated Rings (-346a and -346b).

Figure 33. Labret or Ear Plug (-848).

Bone Artifacts

Thirty-three prehistoric bone implements or fragments were recovered during excavations at SFR-4/H. The majority of the bone implements appear to have been manufactured from large-mammal bone, most commonly artiodactyl—notable because large artiodactyls are very rare in the dietary assemblage. They include bone needles; an antler wedge; a scapula "saw;" a possible strigil; and, most numerous, are pointed and shaped fragments of split mammal longbone. The latter may have been used as awls, fishing implements, or other kinds of tools. Bone tools occur in all components; however, bone needles were restricted to the Middle Period. Twelve of the bone implements were recovered with burials.

Needles

This group consists of four sharp-pointed bone needles, all associated with the Middle Period, formed of tapered splinters of either mammal or large-bird bone. The artifacts are round in cross-section, and each has a single perforation at the flattened, wider end. All are gracile and well finished. In length, the group ranges from 150.5 to 173 millimeters; width at the head varies from 5.8 to 8.3 millimeters; thickness ranges from 1.7 to 2.5 millimeters. These closely resemble Gifford's (1940) Type P3a, "eyed awl or needles less than 200 millimeters long." Gifford cited ethnographic data (1940:174-75) suggesting that a thong was passed through the perforation, and that the needle was worn in a man's topknot and used for fighting. However, he also noted that the specimens used in this fashion were indistinguishable from awls. All four of the needles from SFR-4/H were found in association with Burial 22, which lay in the base of the shell midden. They are assigned to the Middle Period, illustrated with the burial grave lot in Appendix F.

Miscellaneous Bone Tools

Catalogue #816 is a possible antler wedge or chisel (Gifford Type HH), with the tip tapered and flattened in cross-section. There is deep concave wear into the distal edge margin, and moderate polish on both faces. The tool was recovered in Quadrant 3, so is undated.

This artifact (Figure 34) is a medial fragment of a large-mammal scapula with a trimmed distal margin. The proximal end and spine are partly broken off. The lateral margins are deeply serrated, with wide crenellations separated by angular to rounded cuts. This item fits Gifford's (1940:213) type H1, except that both edges of the SFR-4/H specimen are serrated.

Figure 34. Serrate Scapula Tool (-627).

Catalogue #844 is a complete, well-finished spatulate implement formed from the split logbone of an elk or other large mammal. This implement, which was found in association with Middle Period Burial 7 (almost certainly associated with the base of shell midden), is shown in Confidential Appendix F. The artifact is slightly curved in cross-section and longitudinally. Both heads have been completely removed and both ends completely finished. The proximal end is squared off and the distal tip is tapered to a point. The entire artifact is well finished, with faces, ends, and edges highly polished. Several small *Haliotis* and *Olivella* sequins and fragments are set in asphaltum on the outer face at the proximal end, and there are traces of others in the asphaltum, including impressions of what could have been larger *Haliotis* beads or small disks. None of the items illustrated in Gifford's typology closely resembles this artifact, but there are similarities to his types F (strigil), K3 (elk wand), and P2b (dagger).

Pointed Implements Formed on Split Mammal Longbone

This group includes 24 more-or-less similar items, seven from burial associations and the rest from various non-burial proveniences, found across all temporal components. Each is described in detail in Appendix D; they are summarized here by type.

Four whole and four fragmented specimens appear to be what Gifford described as Type A1d: "awl of mammal leg bone with head entirely removed" (1940:169). Our examples are formed from quartered mammal (probably ungulate) longbones with most or all of the head was removed. Generally, the shaft is slender and its split surfaces have been smoothed. Tips are gracile, generally conical, and sharp. The whole tools average about 120 millimeters in length.

Three of the pointed bone implements appear to have had more robust tips; Gifford probably would have placed them in his Class C: "Gouge, Smoother or Flaking tool," rather than with awls. One of the three may be a sea mammal ulna, and another is a minimally modified sea otter baculum. Other atypical items include a pointed, spatulate bone tip formed from split rib or highly finished large artiodactyl longbone; a medial fragment of mammal rib (?) cut and snapped across the shaft at one end; and three sharpened vestigial artiodactyl metatarsals. Also in the collection are four medial fragments of split mammal longbone that cannot be assigned to class.

Bi-Pointed Bone Implements

This group includes three items that were found together in association with Early Period Burial 34 (Figure 35). They were fragmented, calcined, and highly deteriorated either from burning or from chemical weathering. All were formed from split mammal longbones, or possibly ribs, with most or all traces of the epiphyses removed. They had sharp points on one end and were tapered and somewhat flattened on the opposite end. Lengths ranged from 153 to 230 millimeters.

Figure 35. Pointed Mammal Bone Implements (-1426, -227, and -539).

Beads and Ornaments

Three kinds of beads/ornaments were recovered at the site: steatite, fish vertebra, and shell. By far the most plentiful were *Olivella* shell beads found with seven of the burials (1,100 with Middle/Late Transition Burial 4 alone). Milliken and Groza carried out a detailed analysis of the bead lots, presented in Appendix C. Their results are summarized here, along with descriptions of the non-shell items.

Steatite Ornaments

These two items (Cat. 1480 and 1502) are small pendants, each with a tiny perforation at one end, both associated with Early Period Burial 34 (Figure 36). One is a round piece of mottled yellow-green steatite with a domed cross-section and highly polished surfaces. The other is a small trapezoid of finely worked, well-polished black steatite, with a flattened elliptical cross-section. One face is obscured by the application of a dark-colored mastic, possibly asphaltum. The mastic is an irregular mass and does not cover the entire face. Set in the mastic in the center of the face, below the perforation, is a shell sequin (probably *Haliotis*) about 7.1 millimeters in diameter, with two central perforations. The impression of a second sequin is visible in the mastic above the intact sequin, and there are traces of shell embedded in the mastic. A small plaque of another mineral, possibly mica, adheres to the lower corner of the same face. This object was found in a calcified material clinging to the left tibia of the Burial 34 individual.

Figure 36. Pendants (-1480 and -1502).

Fish Vertebra Beads

Two probable fish-vertebra beads were recovered from the midden, one in association with undated Burial 15 and a much larger one in Unit 2 at 73 centimeters depth (Late Period). Both resemble Gifford's type CC5, "perforated spool-like object of fish vertebra" (1940:165, 226). The smaller vertebra has a diameter of 6.1 millimeters; it has been split horizontally, either intentionally or through deterioration, and there is a small perforation through the middle of the centrum. The other vertebra (diameter 17.7 millimeters) obviously represents a much larger fish. One face of this vertebra has been ground flat and has four radial grooves across the lip. These grooves may be natural anatomical features exposed by splitting.

Shell Beads and Ornaments (by Randall Milliken and Randall Groza)

A total of 1,870 shell beads and ornaments was recovered at SFR-4/H during excavations. The items include 1,822 beads from the genus *Olivella* (purple olive sea snail), 34 ornaments from the genus *Haliotis* (abalone), 14 *Haliotis* beads, one bead from the genus *Saxidomus* (clam), and one ornament from the genus *Tegula* (silky turban snail). Only eight of these worked shell artifacts (0.5%) were recovered during volume-controlled hand excavations. The vast majority (1,862 of 1,870 [99.6%]) were associated with burials, discovered during controlled grading.

Shell bead types are classified here according to the Bennyhoff and Hughes 1987 typology, with modification and expansion of the *Olivella* "Saddle" (F) class in accordance with the results of new typological definitions developed by California shell bead specialists at a workshop in 2003. This report uses the newly-developed concept of "shell bead horizons" to denote chronological phases. This concept, and the time brackets used to date these horizons, are discussed in more detail in Appendix C.

Twelve different types or subtypes of *Olivella* shell beads were recovered during excavations at SFR-4/H. These represent Class A (Spire-lopped), Class F (Saddle), Class G (Saucer), and Class M (Sequin Rectangle) in the Bennyhoff and Hughes (1987) typology. Appendix C details the characteristics of each bead type and subtype and reports numbers and contexts for those recovered from SFR-4/H. The information is summarized in Table 18. All were from Middle/Late, Middle, or undated burials; none were from Early or Late contexts.

Table 18. Summary of *Olivella* Shell Beads.

Bead Type	**Context/ Association**	**Temporal Component**	**Number Found**
A1b Spire-lopped	Unit 6, 10-20 cm	Undated	2
A1c Spire-lopped	Unit N19/W4, 10-20 cm	Middle	1
F2a/F2b Full/Round Saddle, Chipped-edge	Burial 7	Middle	21
	Burial 22	Middle	26
	Burial 28	Middle	37
F2c/F2d Rectanguloid/Oval saddle, Chipped edges	Burial 6	Middle	12
	Burial 7	Middle	14
	Burial 22	Middle	37
	Burial 28	Middle	66
F3a/F3b Narrow Saddles (Square variants)	Burial 6	Middle	96
	Burial 12	Middle/Late	8
	Burial 22	Middle	2
F3a2/F3b2 Normal Saddles (Oval variants)	Burial 6	Middle	82
	Burial 7	Middle	8
	Burial 12	Middle/Late	8
	Burial 22	Middle	10
G1 Tiny Saucers	Burial 6	Middle	30
M1a Normal Sequins	Burial 4	Middle/Late	1,094
	Unit N35/E6, 0-10 cm	Undated	1
M1d Wide Sequins	Burial 4	Middle/Late	6
Untypable fragments	various	-	271

Haliotis Shell Beads and Ornaments (with Randall Groza)

Approximately 35 *Haliotis* ornaments and 12 *Haliotis* beads were recovered during excavations at SFR-4/H (see Appendix C for detailed descriptions of methods and results). The ornaments include 18 circular disks, 11 elongated pendants, and six very large gorgets. With the exception of one narrow ring from Unit 6 and one oblong pendant from Unit 2, all of the *Haliotis* beads and ornaments were found in association with burials.

All of the beads came from Middle Period Burial 7; the ornaments were recovered from five different burials and from four units which date from the Early Period to the Middle/Late Transition. In most cases, the associated temporal component corresponds to the temporal significance of the ornament (see Table 10)

The *Haliotis* bead types are classified according to Bennyhoff and Fredrickson's 1967 typology. The ornament types are reported here according to Bennyhoff's ornament typology, partially outlined by Bennyhoff and Hughes (1987:144-146) and more fully documented by Bouey (1995). The ornaments also are categorized in accordance with an alternative typology developed by Gifford (1947). Gifford is very useful as a reference, as he provided illustrations of each type, while Bennyhoff and Hughes did not. Bennyhoff and Hughes' Table 10 (1987:144) cross-references the Bennyhoff and Gifford *Haliotis* ornament type designations.

Because some of the recovered SFR-4/H *Haliotis* ornaments are fragmentary, the total number of specimens and, in some cases, the original form, could not be determined definitively. Each ornament that preserved traces of perforations or other distinctive features was catalogued separately. Tiny fragments for which no form could be discerned, and which bore no mark of perforation, were grouped under a single catalogue number for each burial and were not reported in counts as individual artifacts.

Clam and Snail Shell Ornaments

One clam shell disk bead and one *Tegula* shell ring ornament also were recovered from the site. The clamshell disk (Figure 37) was recovered from Unit 28N/5W at 0-20 centimeters depth (Middle/Late Transition). The shell ring fragment, preliminarily identified as *Tegula funebralis* (turban snail), was found in Unit N11/E2.5 at 20-30 centimeters (Middle/Late Transition; Figure 38).

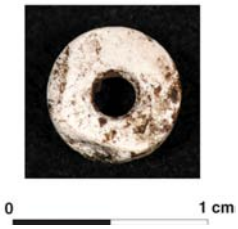


Figure 37. Clam Shell Disk Bead (-271).

Figure 38. *Tegula* Shell Ring Ornament Fragment (-444).

Summary of Shell Beads and Ornaments from SFR-4/H

Most of the shell beads and ornaments recovered from SFR-4/H are time-sensitive, diagnostic of one or another of central California's late Holocene *shell bead horizons* (Hughes and Milliken 2007:262-268). Appendix C provides an in-depth discussion of the temporal implications of these types, and of the bead lots associated with the burials found at the site (including tables of measurements for individual beads sampled from the bead lots). Milliken and Groza also offer an overview of the direct relationship between shell artifact "types" and archaeological phases around San Francisco Bay.

Faunal Remains (with Jeffrey Rosenthal)

A systematic sample of faunal bone and shell was obtained from heavy fractions of 10-x-10-centimeter column sample from 17 hand-excavation units. Three five-gallon (22-l) samples of shell midden, designated Midden 2, Midden 3, and Midden 4, were collected from Trench AA/DD, and shell and bone were extracted from each of these samples. Sample processing and results are described by Dwight Simons in detail in Appendix E.

Mammal and Bird Bone

The assemblage of bird and mammal bone from SFR-4/H is composed mainly of waterfowl, burrowing terrestrial mammals (rodents), and marine mammals. Sea otter bone comprises a sizable majority of the faunal assemblage (Table 19), while large terrestrial mammals (deer and elk) are only minimally represented. Because of its small size, it is unlikely that the island supported a deer or elk population prehistorically, although these animals may occasionally have swum to the island. The small quantities of artiodactyl bone in the assemblage may represent pre-butchered cuts of meat imported from the mainland. The recovered assemblage indicates that prehistoric habitats on and in the vicinity of Yerba Buena Island were similar to those observed historically. Seasonality data on waterfowl and marine pinniped carnivores suggest that the surrounding habitats supported use of SFR-4/H throughout the year.

Table 19. Summary of Identified Faunal Remains by Stratum at SFR-4/H.

	Strata					Grand Total
	II a	**II a,b**	**II b**	**II c**	**III**	
Terrestrial Mammals						
Tule Elk (*Cervus elaphus*)	1	-	-	-	-	1
Black-tailed Deer (*Odocoileus hemionus*)	6	-	-	1	-	7
Dog/Coyote (*Canis* spp.)	10	-	-	2	-	12
Black-tailed Hare (*Lepus californicus*)	4	-	-	-	-	4
Cottontail (*Sylvilagus* spp.)	2	-	-	-	-	2
California meadow mouse (*Microtus californicus*)	33	2	40	137	44	256
Broad-handed Mole (*Scapomus latimanos*)	-	-	3	3	-	6
Pocket gopher (*Thomomys bottae*)	-	-	1	4	2	7
Large Artiodactyl (*Cervus/Bos* spp.)	24	-	-	-	-	24
Medium Artiodactyl (*Sus/Odocoileus /Antilocapra/Ovis/Capra* spp.)	6	-	2	2	-	10
Mammal-Carnivore	5	1	2	3	-	11
Total	90	3	48	152	46	340
Marine Mammals						
California Sea Lion (*Zalophus californianus*)	25	4	1	3	-	33
Harbor Seal (*Phoca vitulina*)	37	8	23	7	-	75
Sea Otter (*Enhydra lutris*)	138	87	156	123	12	516
Harbor Porpoise (*Phocoena phocoena*)	-	-	-	1	-	1
Cetacean?	9	-	-	-	-	9
Total	200	99	180	133	12	634
Land Birds						
Crow (*Corvus brachyrhynchos*)	1	-	4	-	-	5
Buck-Crowned Night Heron (*Nycticorax nycticorax*)	-	-	-	1	-	1
Falcon (*Falco* spp.)	-	-	1	-	-	1
Falconiformes	-	-	1	-	-	1
Hawk (*Accipiter* spp.)	-	-	-	1	-	1
Raven (*Corvus corax*)	-	1	-	2	-	3
Pigeon Guillemot (*Cepphus columba*)	1	-	3	4	-	8
Passeriform bird	5	-	2	19	1	27
Total	7	1	11	27	1	47

Table 19. Summary of Identified Faunal Remains by Stratum at SFR-4/H *continued.*

	Strata					Grand Total
	II a	**II a,b**	**II b**	**II c**	**III**	
Water Birds						
Grebe (*Aechmophorus* spp.)	3	1	1	4	-	9
Grebe (*Podiceps* spp.)	10	2	1	8	1	22
Gull (*Larus* spp.)	4	-	1	2	-	7
Loon (*Gavia* spp.)	6	1	3	8	-	18
Scolopacid Shorebird (cf. Marbled godwit *Limosa fedoa*)	1	-	-	-	-	1
Scolopacid Shorebird (cf. Sandpiper *Calidris* spp.)	1	-	-	1	1	3
Scolopacid Shorebird (cf. Willet *Catoptrophorus semipalmatus*)	1	-	-	-	-	1
Pelican (*Pelecomus* spp.)	1	-	-	-	-	1
Cormorant (*Phalacrocorax* spp.)	15	1	10	18	1	45
Common Murre (*Uria aalge*)	32	3	9	4	-	48
Duck (*Anas/Agytha/Bucephalae/Melanitta/Oxyone* spp.)	84	19	48	31	4	186
Goose (*Anser/Branta/Chen* spp.)	14	3	9	4	-	30
Total	172	30	82	80	7	371
Non-native animals						
Chicken (Gallus gallus)	6	-	-	1	-	7
Domestic cat (Felis silvestris)	1	-	-	-	-	1
Domestic Cow (Bos taurus)	8	1	3	-	-	12
Domestic Horse (Equus caballus)	10	-	-	-	-	10
Domestic Pig (Sus scrofa)	7	-	-	-	-	7
Domestic Sheep (Ovis aries)	-	-	1	-	-	1
Rat (Rattus sp.)	17	-	-	1	-	18
Total	49	1	4	2	-	56
Identified Bone Total	518	134	325	394	65	1,678
Misc.						
Fish bone	3,879	320	1,045	1,465	137	6,846
Marine Mammal TBI	241	79	139	100	5	564
Bird-TBI	121	21	31	57	-	230
Misc. bone fragments	1,856	456	856	1,364	136	4,668
Total	6,097	876	2,071	2,986	278	12,078
Grand Total	6,203	1,010	2,818	3,381	344	13,756

About half of the mammal bone assemblage (by count) comprises small-rodent bones (i.e., moles, gophers, meadow mice, rats). Simons suggests that these rodents arrived on the island through human agency (in animal fodder), likely during the historic period, and that rodent bone likely represents historic intrusions in the midden, rather than prehistoric food items. However, since the ethnographic record reports gophers and mice in the diet, it is possible that the small rodent remains are dietary. If so, the quantities of bone present indicate that these would have been a substantial part of the SFR-4/H prehistoric diet.

Prehistoric inhabitants of SFR-4/H focused on the taking of waterfowl and marine mammals that probably came from habitats located in the site's immediate catchment. Ducks, geese, and sea otters were particularly emphasized, and sea otter bone predominates in the assemblage. Sea otter butchering patterns suggest these animals were utilized for both their pelts and their meat.

The presence of a probable golden eagle burial conforms to prior archaeological and ethnographic data that support animal ceremonialism in the prehistoric San Francisco Bay Area.

The element distribution and butchering techniques of historic faunal remains from SFR-4/H are consistent with on-site butchering of whole animals and a late-nineteenth century military post occupation. The distribution of non-native species in the deposit indicated historic intrusions in the deposit to a depth of at least 50 centimeters, confined mainly (88%) to Stratum IIa.

The proportion of different mammal and bird taxa in the diet varied little over time at SFR-4/H, based on analysis of dietary bone from the four main stratigraphic units (i.e., Stratum IIa, IIb, IIc, and III; see Table 19). However, some differences are apparent, particularly during the Late Period. As noted above, sea otter remains are the dominant marine mammal bone at SFR-4/H. However, there is about a 30% decline in their frequency over time (Table 20; Figure 39) relative to both California sea lion and harbor seal; the latter both increased in proportion from the Early through Late periods (i.e., Stratum III through IIa; Figure 39). Likewise, the proportion of sea mammal bone relative to that of medium and large terrestrial mammal also declined during the Late Period, suggesting greater provisioning from the mainland during the most recent occupation of the site (Table 21).

Table 20. Identified Pinniped and Otter Bone by Stratigraphic Component.

	Late	Middle/Late Transition	Middle	Early	Total
	%	%	%	%	%
California Sea Lion (*Zalophus californianus*)	13	1	2	-	5
Harbor Seal (*Phoca vitulina*)	19	13	5	-	12
Sea Otter (*Enhydra lutris*)	69	87	92	100	83

Table 21. Proportion of Medium-Large Terrestrial Mammal versus Pinniped and Otter

	Late	Middle/Late Transition	Middle	Early	Total
	%	%	%	%	%
Medium and Large Mammal	16	1	2	0	6
Pinniped and Otter	84	99	98	100	94

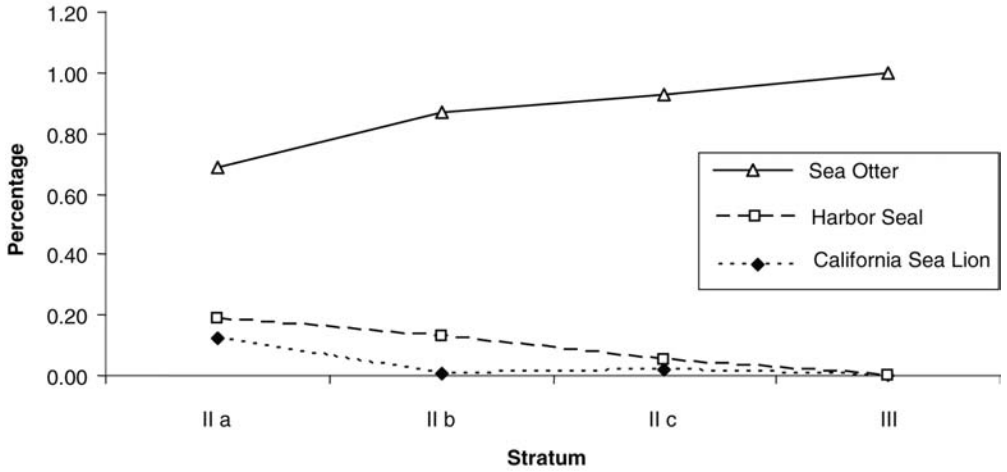


Figure 39. Proportion of Marine Mammal Bone by Stratum at SFR-4/H.

Variability over time is also evident among the assemblage of waterbirds (Table 22). Ducks, while dominant throughout the sequence, reach greatest abundance (60%) in the Middle-Late Transition component and decline slightly in the Late Period Stratum. The greatest changes, however, are evident among the remains of Cormorant and Murre. Cormorant declines from almost 25% of the assemblage in the Middle Period stratum to less than 10% in Late Period contexts. The reverse is true for the Common Murre, which more than triples in abundance from the Middle (5%) to Late Period (19%).

Lastly, while not common in the overall collection, terrestrial birds are found mainly in the Middle Period Stratum (57%; Table 23). The Middle-Late Transition stratum contained more than 23% of the terrestrial bird remains, while the Late Period component contained relatively few, just 15% of this total assemblage.

Table 22. Identified Bone of Water Birds by Component.

	Late	Middle/Late Transition	Middle	Early	Total
	%	%	%	%	%
Grebe (*Aechmophorus* spp.)	2	1	5	-	2
Grebe (*Podiceps* spp.)	6	1	10	14	6
Gull (*Larus* spp.)	2	1	3	-	2
Loon (*Gavia* spp.)	3	4	10	-	5
Scolopacid Shorebird (cf. Marbled godwit *Limosa fedoa*)	1	-	-	-	0
Scolopacid Shorebird (cf. Sandpiper *Calidris* spp.)	1	-	1	14	1
Scolopacid Shorebird (cf. Willet *Catoptrophorus semipalmatus*)	1	-	-	-	0
Pelican (*Pelecomus* spp.)	1	-	-	-	0
Cormorant (*Phalacrocorax* spp.)	9	12	23	14	12
Common Murre (*Uria aalge*)	19	11	5	-	13
Duck (*Anas/Agytha/Bucephalae/Melanitta/Oxyone* spp.)	49	59	39	57	50
Goose (*Anser/Branta/Chen* spp.)	8	11	5	-	8
Total					

Table 23. Proportion of Terrestrial Birds by Component.

	Late	Middle/Late Transition	Middle	Early	Total
	%	%	%	%	%
Crow (*Corvus brachyrhynchos*)	14	36	-	-	11
Buck-Crowned Night Heron (*Nycticorax nycticorax*)	-	-	4	-	2
Falcon (*Falco* spp)	-	9	-	-	2
Falconiformes	-	9	-	-	2
Hawk (*Accipiter* spp.)	-	-	4	-	2
Raven (*Corvus corax*)	-	-	7	-	6
Pigeon Guillemot (*Cepphus columba*)	14	27	15	-	17
Passeriform bird	71	18	70	100	57
Total					

Fish Bone

More than 14,000 fish bones and scales were recovered during excavations. Recovered materials were extracted primarily from the 139 column samples recovered from the 17 hand-excavation units. The analysis of these materials was conducted by Dr. Kenneth Gobalet et al. at CSU Bakersfield; results of this analysis

are detailed in Appendix E. Gobalet also presents a comparative analysis of archaeological fish assemblages around the Bay to support his contention that the prevailing pattern in fish exploitation was a reliance on habitats in the immediate site vicinity.

Some 2,500 fish scales were recovered, as well as numerous bones of small fish species. Over 80% of the recovered materials represent three fish clades, the family Atherinopsidae (silversides), the genus *Sebastes* (rockfishes), and the family Embiotocidae (surfperches). In Gobalet's interpretation, these represent species that frequent rocky and sandy bottoms, kelp beds, and surf, and that could have been caught from the shore with hook and line or net. There is little evidence in the assemblage of the exploitation of deepwater fish, or of those that frequent shallow waters of the mudflats.

Clear differences over time occur in the frequency of the primary fishes recovered from SFR-4/H. Initially abundant silversides (Atherinidae) and herring/sardine (Clupeidae) bone decline in the Late Period stratum, whereas the remains of rockfishes (*Sebastes* spp.) and serfperches (Embiotocidae) increase. Less abundant species also show temporal changes, including Salmon/trout (*Oncorhynchus* spp.) which decline from the Early through Late Periods and Plainfin midshipman (*Porichthys notatus*) which show a similar trend (Table 24). Requiem shark (Carcharchinidae) remains are most frequent in the Middle and Middle-Late Transition Strata, but also decline during the Late Period.

Table 24. Primary Identified Fishes, by Component.

	Late		Middle/Late Transition		Middle		Early		Total	
	#	%	#	%	#	%	#	%	#	%
Atherinidae (topsmelt and jacksmelt)	1,051	17	412	26	458	19	77	30	1,998	19
Carcharchinidae (requiem sharks)	134	2	109	7	105	4	3	1	351	3
Clupeidae (herring/sardine)	376	6	145	9	329	13	39	15	889	9
Embiotocidae (surfperches)	1,865	31	442	28	543	22	58	22	2,908	28
Oncorhynchus spp. (pacific salmon and trout)	133	2	75	5	57	2	22	8	283	3
Porichthys notatus (plainfin midshipman)	92	2	18	1	247	10	11	4	368	4
Sebastes spp. (rockfishes)	2,028	34	240	15	530	21	19	7	2,817	27
All others	330	6	151	10	206	8	30	12	721	7
Total	6,009		1,592		2,475		259		10,335	

Shellfish

Shell was extracted from the heavy fraction from 16 of the 17 units excavated in 2002. *Mytilus* spp. (mussel) comprised about 80% of the sample by weight, with *Macoma nasuta* (bent-nosed clam) the second most common species, contributing about 14%. This strong predominance of mussel may be somewhat deceptive, since the 2002 analysis grouped unidentifiable crushed shell with mussel on the basis of overall blue coloration and appearance of the residual shell. Nonetheless, *Mytilus* predominated at all levels of the sample in all units. The species recovered in the shell sample were all consistent with local collection on rocky shores, and in the intertidal zone in the more sheltered East Cove of the island.

Shell, primarily crushed mussel with some clam and oyster and an occasional scattering of other species, was estimated to comprise at least 25% of the volume of the Unit A midden. Dietary shell was noted throughout Unit B in quantities estimated at 5 to 25% of soil volume. Qualitatively, by blue mussel (*Mytilus trossulus*), which occurred mainly as small fragments, predominated, although the clam, oyster, and snail species were noted in other units. No quantitative sample of shell was recovered from these units.

Analysis of shell recovered from stratum samples revealed that shell comprised 12.75% of the midden volume. *Mytilus* spp. (probably *M. trossulus*) was strongly predominant, comprising about 60% of the sample. *Macoma nasuta* (bent-nosed clam) was second in predominance, and the assemblage included small quantities of *Ostrea lurida* (bay oyster) and a variety of other local species. *Haliotis* (abalone) or *Olivella* (olive snail) occurred at the site only as ornaments, primarily in association with burials. None was recovered in the dietary shell sample, nor did the sample include any bead or ornament manufacturing debris. Analysis of shellfish by component further reveals that the proportion of *Macoma* more than doubled over time (Table 25), from just 9% by weight in the Early Period stratum to 20% in Late Period contexts.

Table 25. Shellfish Proportion by Component.

	Late	Middle/Late Transition	Middle	Early
	%	%	%	%
Balanus spp.	1	1	1	1
Cancer spp.	0	0	0	0
Clinocardium nuttallii	1	1	1	0
Colisella pelta	0	0	0	0
Fusitriton oregonensis	0	0	0	0
Gastropod spp.	4	3	3	3
Katharina tunicate	0	0	0	0
Macome nasuta	20	14	9	9
Mytilus spp. + unidentifiable fragments	73	82	85	86
Ostrea lurida	1	1	1	1
Protothaca staminea	0	0	0	0
Tresus nuttallii	0	0	0	0
Total (weight)	14,070.5	4,489	8,631.5	1,311.5

Archaeobotanical Materials

Macrobotanical samples were extracted from 60 column samples from controlled excavation units within the shell midden. Popper's detailed results are provided in Appendix E. In general, the yield of plant materials from SFR-4/H was low, although the presence of charcoal in most units indicated that at least some plant remains would be preserved. The majority of carbonized plant remains recovered were small seeds (Table 26).

Oak wood charcoal was the most ubiquitous plant material at the site, occurring in 80% of the samples. This indicates that oak trees were readily available on the island and were used for firewood. Carbonized acorn parts also occurred in 13% of the samples. Other taxa that were represented with some frequency included *Chenopodium* spp. (goosefoot) with 23% ubiquity, Asteraceae (sunflower family, tarweed), with 22% ubiquity, and *Galium* spp. (bedstraw), with 23% ubiquity. *Phacelia* spp. (phacelia) occurred in 12% of the samples, and Poaceae (brome grass and hair grass) in 15% of the samples.

Component-associated comparisons reveal that nut remains were low throughout the sequence (Table 26). In contrast, small grass seed increase significantly in the Late Period components. This change is largely due to a increase in grass seeds. Plant representation suggests that the site was used in the spring, summer, and fall. The generally low densities of carbonized plants indicates plant food collecting and processing were not major activities at the site.

Table 26. Plants by Component.

Component		Late		Middle/Late Transition		Middle		Early	
Volume (liters)		19		14		13		7	
Taxon	**Common Name**	**Count**	**Density**	**Count**	**Density**	**Count**	**Density**	**Count**	**Density**
Small Seeds (Genus)									
Amsinckia spp. cf.	Fiddleneck			1	0.05				
Bromus spp.	Brome grass	29	1.53						
Cheno-Ams						3	0.23		
Chenopodium spp.	Goosefoot	7	0.37	22	1.57	5	0.38		
Deschampsia spp. cf.	Hairgrass	0	0.00	2	0.14				
Galium spp.	Bedstraw	9	0.47	2	0.14	9	0.69		
Hypericum spp. cf.	St. John's Wort					1	0.08		
Madia spp.	Tarweed	1	0.05	1	0.07				
Phacelia spp.	Bluebell	8	0.42			13	1.00	1	0.14
Scirpus spp.	Tule	1	0.05						
Type 1		1	0.05			4	0.31		
Type 3		1	0.05						
Vulpia spp.	Fescue	1	0.05						
Small Seeds (Family)									
Brassicaceae	mustard	5	0.26	1	0.07	6	0.46		
Centrospermae	centrosperm	4	0.21			1	0.08		
Cyperaceae	sedge	1	0.05						
Fabaceae	bean	4	0.21	5	0.36	2	0.15		
Malvaceae	mallow	2	0.11	1	0.07	4	0.31		
Poaceae	grass	1	0.05						
Poaceae fragments	grass	522	27.47	23	1.64	8	0.62		
Unidentifiable seeds		310	16.32	28	2.00	36	2.77	4	0.57
Total Small Seeds		907	47.74	85	6.07	92	7.08	5	0.71
Nutshell		**Weight**	**Density**	**Weight**	**Density**	**Weight**	**Density**	**Weight**	**Density**
Aesculus californica		1	0.05						
Corylus cornuta	Hazel nut					9	0.69		
Marah spp.	Wild cucumber			0.5	0.04	4	0.31		
Quercus spp. nutshell	Oak acorn	10.5	0.55	4	0.29	0.7	0.05	0.8	0.11
Umbellularia californica	Bay nut	10.2	0.54						
Unidentified nutshell		4.5	0.24			1	0.08		
Total Nutshell		26.2	1.38	4.5	0.32	14.7	1.13	0.8	0.11
Corms and Fruits									
Corm fragment cf.		40	2.11	70	14.00	29	2.23		
Unknown fruit				1	0.07				
Wood Charcoal (grams)									
Total Wood Charcoal		45.02	2.37	25.21	1.80	3.95	0.30	0.26	0.04